3.0 Description of Proposed Facility

3.1 In Situ Leach Process and Equipment

The ISL process involves the oxidation and solublization of uranium from its reduced state using a leaching solution (lixiviant). The leach solution consists of ground water with an oxidant, such as gaseous oxygen, added to oxidize the uranium to a soluble valence and gaseous carbon dioxide to complex and solubilize the uranium. At the PAA, Powertech (USA) will add gaseous oxygen and gaseous carbon dioxide to the recirculated ground water from the ore zone aquifer. Once solubilized, the uranium bearing ground water will be pumped by submersible pumps in the production wells in the well field to the surface where it is ionically bonded onto IX resins. After the uranium is removed, the groundwater will be recirculated and reinjected via the injection wells in the well field. When the IX resin is loaded with uranium, the loaded resin is moved to an IX elution (stripping) column where the uranium is eluted (stripped) off the resin by a salt water solution. The resulting barren resin is then recycled to recover more uranium. The salt water eluate solution is pumped to a precipitation process where the uranium is precipitated as a yellow solid uranium oxide. The precipitated uranium oxide is then filtered, washed, dried and packaged in sealed containers for shipment for further processing.

Typically, an ISL well field consists of a set of contiguous geometric shaped patterns of injection and production wells. Powertech (USA) will mostly utilize square or rectangular patterns, sometimes hexagons or triangles to cover the economically recoverable portions of the uranium deposit. This provides for uniform distribution of leach fluid (lixiviant) to efficiently contact the economically recoverable portions of the uranium orebody. The injection wells will be located at the corners of the geometric patterns and the production wells will be in the center of the geometric patterns. Powertech (USA) will withdraw 0.5 to 3 percent more ground water than is reinjected to maintain a flow of outside baseline quality groundwater into the production well field and to prevent the flow of leach fluid to the monitor well ring surrounding the orebody. The excess produced water (bleed) creates and maintains a cone of depression in the pressure surface of the aquifer so that the native ground water is continually flowing to the center of the production zone. This bleed also helps Powertech (USA) control and limit the increase in the sulfate and chloride concentration in the leach solution.

At the surface, the pregnant lixiviant flows through IX columns, where the uranium is transferred to resin. The resin will be trucked or piped to a CPP for further refinement into yellowcake - the final product for the first stage of the uranium fuel cycle.

The barren lixiviant is re-fortified with oxygen and carbon dioxide and re-circulated through the orebody to leach uranium.

Powertech (USA) proposes to use a lixiviant consisting of varying concentrations of oxygen (O2) and carbon dioxide (CO2) added to the native groundwater to promote the dissolution of uranium as a uranyl carbonate anionic complex. The expected or typical lixiviant concentrations and compositions are shown in Table 3.1-1. This lixiviant formulation will minimize ground water quality potential impacts during uranium recovery and enable restoration goals to be achieved in a timely manner (NUREG-1569, 2003).

Table 3.1-1: Typical Lixiviant Concentrations and Compositions

Constituent	Units	Concentration Range	
		Minimum	Maximum
Calcium	mg/L	≤20	500
Sodium	mg/L	≤400	6000
Magnesium	mg/L	≤3	100
Potassium	mg/L	≤15	300
Chloride	mg/L	≤200	5000
Carbonate	mg/L	≤0.5	5000
Bicarbonate	mg/L	≤400	5000
Sulfate	mg/L	≤400	5000
Uranium	mg/L	≤0.01	500
Vanadium	mg/L	≤0.01	100
pH	Std units	≤6.5	10.5
Total Dissolved Solids, TDS	mg/L	≤1650	12000

Notes:

Table adapted from USNRC (2008) Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities-Draft Report for Comment. NUREG-1910. July 2008.

For purposes of the proposed action, it is anticipated that lixiviant concentrations will be within the parameters outlined in Table 3.1-1. The ISL process involves an oxidation step that converts uranium in the solid state to a form that is easily dissolved by the leaching fluid. The reactions representing these steps are as follows:

Oxidation: UO_2 (solid) + ½O_2 (in solution) → UO_3 (at solid surface)

Dissolution: $UO_3 + 2\ HCO_3^{-1} \rightarrow UO_2(CO_3)_2^{-2} + H_2O$

$UO_3 + CO_3^{-2} + 2HCO_3^{-1} \rightarrow UO_2(CO_3)_3^{-4} + H_2O$

The principal uranyl carbonate ions formed as shown above are uranyl dicarbonate, $UO_2\,(CO_3)_2^{-2}$ [i.e., UDC] and uranyl tricarbonate $UO_2(CO_3)_3^{-4}$ [i.e., UTC]. The relative abundance of each is a function of pH and total carbonate strength.

The uranium-rich lixiviant is then extracted via production wells and pumped to an ion-exchange facility near the well field. At an IX facility, the uranium is removed from the pregnant lixiviant by IX onto resins.

Logistically, if the IX process occurs at a SF, the uranium-rich resin is physically removed from the IX columns at the SF and transported via tanker truck to the CPP where uranium is eluted from the resin. Regenerated resin is then returned to the IX columns within the SF. If IX occurs at the CPP, trucking is not necessary.

The following paragraphs describe the upfront uranium processing facilities, including: well field layout; design and construction of injection, production, and monitoring wells; layout of header houses and associated infrastructure; leak detection and cleanup procedures; water balance and general well field operations; evaporation ponds and land application areas; waste disposal well sites; surface water management; quality control; 11e.(2) waste disposal agreements, and ISL references.

3.1.1 Orebody

For a description of the orebody and mineralized zones see the geology Section 2.6. The aquifer characterization is summarized in Section 2.7

3.1.1.1 Approach to Well Field Development

An ISL well field consists of a series of injection and production wells that are completed across the target mineralization zone. Prior to design of the wells, the ore bodies will be delineated with exploration holes drilled on 100-feet centers. As discussed earlier, these holes will be geologically and geophysically logged Using this information, each new injection and production well will be assigned lateral coordinates, a ground surface elevation, depth to base of casing, i.e., top of completion interval, and length of completion interval, before it is drilled.

For all injection and production wells, the base of casing will be established at or below the confining unit overlying the mineralized zone. The screened interval will be completed only across the targeted ore zone.

A typical (100 x 100 ft grid) well field layout is illustrated on Plate 3.1-1. This typical layout is based on the lateral distribution and grade of one of the uranium deposits within the PAA.

The well field patterns may differ from well field to well field, but a typical pattern will consist of five wells, with one well in the center and four wells surrounding it oriented in four corners of a square between 50 and 150 feet. Typically, a production well is located in the center of the pattern, and the four corner wells are injection wells. Such a pattern will be modified as needed to fit the characteristics of each orebody. A typical well pattern for an orebody is illustrated in Plate 3.1-1.

The pattern dimensions will vary depending on the geometry of the orebody. All wells will be completed so they can be used as either injection or production wells, so that well field flow patterns can be changed as needed to improve uranium production and restore groundwater quality in the most efficient manner. Other well field designs that may be considered include alternating single lines of production and injection wells.

Production and injection wells will be connected to a common header house, as shown on Plate 3.1-2. Well head connection details for injection and production wells are illustrated on Figures 3.1-1 and 3.1-2, respectively.

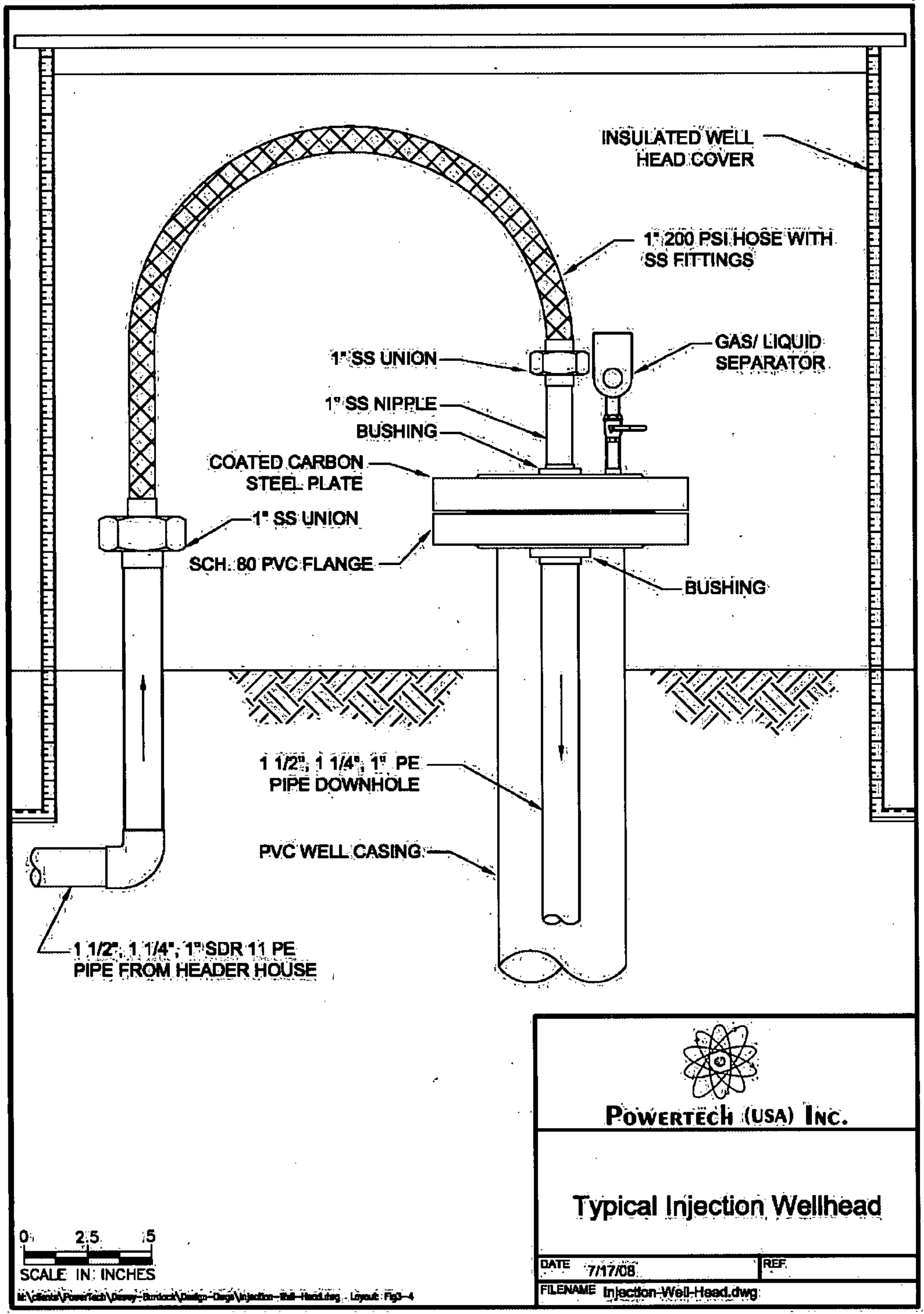

Figure 3.1-1: Typical Injection Wellhead Diagram

POWERTECH (USA) INC.

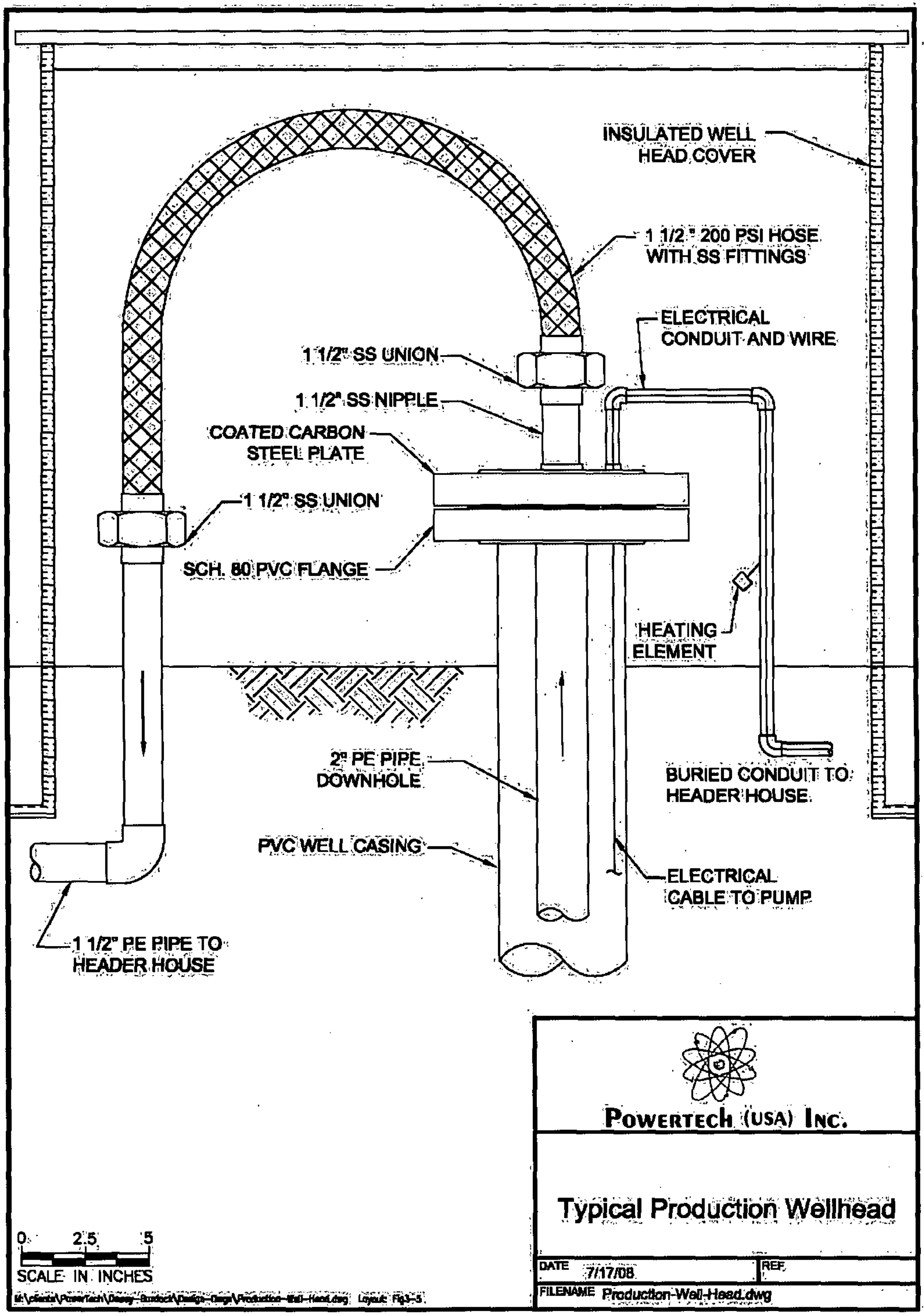

Figure 3.1-2: Typical Production Wellhead Diagram

Typically, one header house will service up to 20 production wells and 80 injection wells. Piping between the wells and header house will consist of high density polyethylene (HDPE) pipe with heat-welded joints, buried approximately 5 feet below grade. The piping will typically be designed for operating pressure of 150-300 psig, but actual pressures will typically be less than 100 psig. The piping will terminate at the header house where it will be connected to manifolds equipped with control valves, flow meters, check valves, pressure sensors, oxygen and carbon dioxide feed systems (injection only), and programmable logic controllers. Electrical power to the header houses will be delivered via overhead power lines and via buried cable. Electrical power to the header houses will be delivered via overhead power lines and via buried cable (see Figure 2.2-1). Electrical power to individual wells will be delivered via buried cable from the header house.

As a well field expands, additional header houses will be constructed. They will be connected to one another via buried header piping that is sized to accommodate the necessary injection and production flow rates and pressures. In turn, header pipes from entire well fields will be connected to either a SF or CPP, as discussed earlier. A piping detail that shows the connection between the main header piping and laterals to header houses is shown in Plate 3.1-2.

Monitoring wells will be positioned around the perimeter of each well field ring, as illustrated on Plate 3.1-1. Internal to the well field additional monitoring wells will be installed. Perimeter wells will be screened across the entire mineralized zone to monitor for potential lateral excursion within the zone outside the well field, and to demonstrate compliance with groundwater quality standards within this zone. Internal monitoring wells will be screened across the overlying and underlying aquifers, respectively, where the greatest potential for vertical excursion may occur. An in-depth discussion of the positioning and spacing of monitoring wells is provided in Section 3.1.3 of this application.

3.1.2 Well Construction and Integrity Testing

Well construction materials, methods, development, and integrity testing are described in the following subsections.

3.1.2.1 Well Materials of Construction

Well casing material will typically be thermoplastic such as polyvinyl chloride (PVC). Wells typically will be 4, 5 and 6-inch nominal diameter, with wall thickness appropriate for design conditions. In order to provide an adequate annular seal, the drill hole diameter will be at least two inches greater in nominal diameter than the outside diameter of the well casing. The annular seal will be pressure-grouted and sealed with either cement grout or bentonite grout.

Casing will be joined by fittings or using methods recommended by the casing manufacture.

3.1.2.2 Well Construction Methods

Typical well installation will begin with drilling a pilot bore hole through the ore zone to obtain a measurement of the uranium grade and the depth. The pilot bore hole will be geologically and geophysically logged. After logging, the pilot bore hole will be reamed to the appropriate diameter to the top of the ore zone. A continuous string of PVC casing will be placed into the reamed borehole. Casing centralizers will be installed as appropriate. With the casing in place a cement/bentonite grout will be pumped into the casing. The grout will circulate out the bottom of the casing and back up the casing annulus to the ground surface. The volume of grout necessary to cement the annulus will be calculated from the bore hole diameter of the casing with sufficient additional allowance to achieve grout returning to surface. Grout remaining inside the well casing may be displaced by water or heavy drill mud to minimize the column of the grout plug remaining inside the casing. Care will be taken to assure that at a grout plug remains inside the casing at completion. The casing and grout will then be allowed to set undisturbed for a minimum of 24 hours. When the grout has set, if the annular seal observed from the ground surface has settled below the ground surface, additional grout will be placed into the annular space to bring the grout seal to the ground surface.

After the 24-hour (minimum) setup period, a drill rig will be mobilized to finish well construction by drilling through the grout plug and through the mineralized zone to the specified total well depth. As illustrated in Figure 3.1-3, the open borehole will then be underreamed to a larger diameter.

A well screen assembly will then be lowered through the casing into the open hole. The top of the well screen assembly will be positioned inside the well casing and centralized and sealed inside the casing using "K" packers. With the drill pipe attached to the well screen, a one-inch diameter tremie pipe will be inserted through drill pipe and screen, and through the sand trap check valves at the bottom of well screen assembly. Filter sand, comprised of well rounded silica sand sized to optimize hydraulic communication between the target zone and well screen, will then be placed between the well screen and the formation. The volume of sand introduced will be calculated such that it fills the annular space. The sand will not extend upward beyond the K packers due to packer design. A well completion report will then be prepared for each well. The reports will be kept available on-site for review. Copies will be submitted to regulatory agencies upon request.

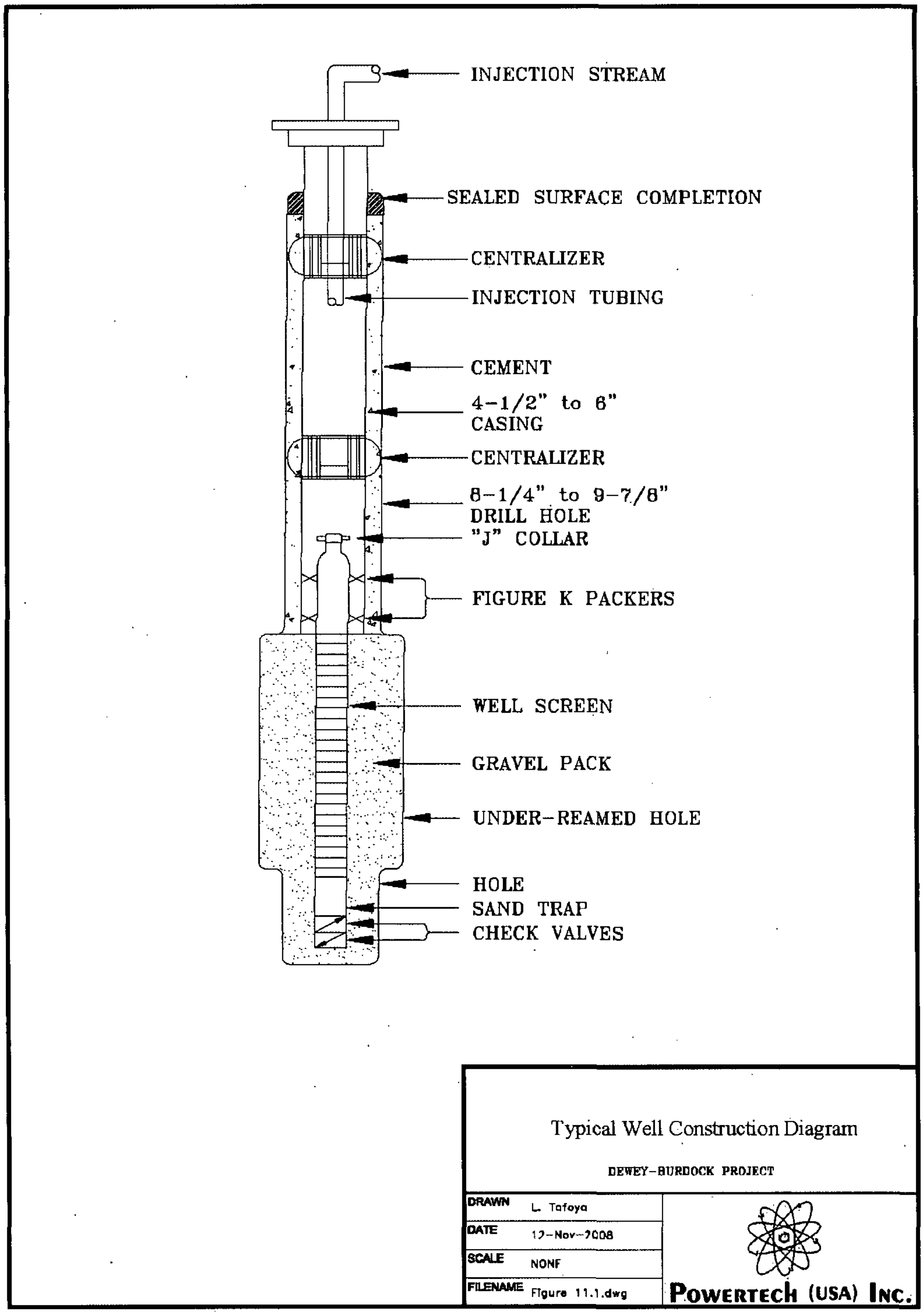

Figure 3.1-3 Typical Well Construction

3.1.2.3 Well Development

The primary goals of well development are to allow formation water to enter the well screen and flush out drilling mud, or cement filtrate water and to develop the well bore to remove the finer clays and silts to reduce the pressure drop between the formation and the well screen. This process is necessary to allow representative samples of groundwater to be collected, if applicable, and to ensure efficient injection and production operations. Wells will be developed immediately after construction using air lifting, swabbing, pumping or other accepted development techniques which will remove water and drilling fluids from the casing and borehole walls along the screened interval. Prior to obtaining baseline samples from monitor or restoration wells, additional well development will be conducted to ensure that representative formation water is sampled. The water will be pumped sufficiently to show stabilization of pH and conductivity values prior to sampling and used to indicate that development activities have been effective.

3.1.2.4 Well Integrity Testing

Field-testing of all injection, recovery, and monitor wells will be performed to demonstrate the mechanical integrity of the well casing. The mechanical integrity test (MIT) will be performed using pressure-packer tests. The bottom of the casing will be sealed with a plug, downhole packer, or other suitable device. The casing will be filled with water and the top of the casing will be sealed with a threaded cap or mechanical seal. The well casing will then be pressurized with water or air and monitored with a calibrated pressure gauge. Internal casing pressure will be increased to 125 percent of the maximum operating pressure of the well field, 125 percent of the maximum operating pressure rating of the well casing (which is always less that the maximum pressure rating of the pipe), or 90 percent of the formation fracture pressure (which equates to approximately 1 psi per foot of overburden above the bottom of casing), whichever is less. A well must maintain 90 percent of this pressure for a minimum of 10 minutes to pass the test.

If there are obvious leaks, or the pressure drops by more than 10 percent during the 10 minute period, the seals and fittings on the packer system will be checked and/or reset and another test will be conducted. If the pressure drops less than 10 percent the well casing will have demonstrated acceptable mechanical integrity.

If a well casing does not meet the MIT criteria, the well will be removed from service. The casing may be repaired and the well re-tested, or the well may be plugged and abandoned.

Plugging of wells will be in accordance with the EPA regulations located in Title 40 Part 146.10 which comply with the South Dakota Administrative Rules contained in Chapter 74:55:01:59. DENR will be notified of any well that fails the MIT. If a repaired well passes the MIT, it will be employed in its intended service following approval from EPA and/or DENR that the well has demonstrated mechanical integrity. If an acceptable test cannot be demonstrated following repairs, the well will be plugged and abandoned.

In addition to the integrity testing of new wells, a MIT will be conducted on any well following any repair where a downhole drill bit or under-reaming tool is used. Any injection well with evidence of suspected subsurface damage will require a new MIT prior to the well being returned to service. Mechanical integrity tests will also be repeated once every five years for all active wells.

The MIT of a well will be documented to include the well designation, date of test, test duration, beginning and ending pressures, and the signature of the individual responsible for conducting the test. Results of the MITs will be maintained on-site and will be available for inspection by EPA and DENR. Results of MIT shall be reported within quarterly reports in accordance with the EPA UIC regulations in Title 40 Part 146.33 which also meet the DENR requirements in § 74:55:01:49.

3.1.3 Monitoring Well Layout and Design

As discussed in Sections 5 and 6 of this application, an extensive groundwater sampling program specific to each well field will be conducted prior to, during, and following ISL operations to identify any potential impacts to water resources of the area. The groundwater monitoring program for individual well fields is designed to (1) establish baseline water quality prior to production, (2) detect excursions of lixiviant either horizontally or vertically outside the of the target mineralization zone, (3) demonstrate compliance with groundwater quality standards, and (4) determine when the mined mineralized zone has been adequately restored following ISL operations. Objectives 1 (partially) and 4 will accomplished using injection and recovery wells. Objectives 1 (partially), 2, and 3 will be accomplished using perimeter and internal non-production zone monitoring wells.

The production wells are laid out in a regular grid to efficiently contact the mineralized deposit (Figure 3.1-4). Generally, the wells are laid out in regular geometric shapes, usually squares, rectangles, triangles, or hexagons. The important features are that the patterns cover the economically mineable portions of the orebody, the production (pumping) well is in the center of each geometric shape, the injection wells are equally spaced from each other and from the production wells in each pattern (geometric shape). This is to ensure efficient contacting of the ore by uniform flow distribution and to facilitate control of the flow to prevent excursion of leachate to the monitor well ring. The injection wells are on the outside to ensure the ore is contacted with leachate and a bleed withdrawing of some 0.5 to 3 per cent of the leachate circulating to maintain a cone of depression ensuring outside groundwater in the ore zone flows in toward the production well field to prevent flow of leachate outwards (NMA, 2007).

The production zone monitor wells are completed in the ore zone around the perimeter of the production well fields spaced 400 feet outside the production well field and evenly spaced around the perimeter of the well field with a minimum spacing either 400 feet or the spacing that will ensure a 70 degree angle between adjacent production zone monitor wells and the nearest injection well (NUREG/CR-6733; NUREG-1910, 2008; NUREG-1569).

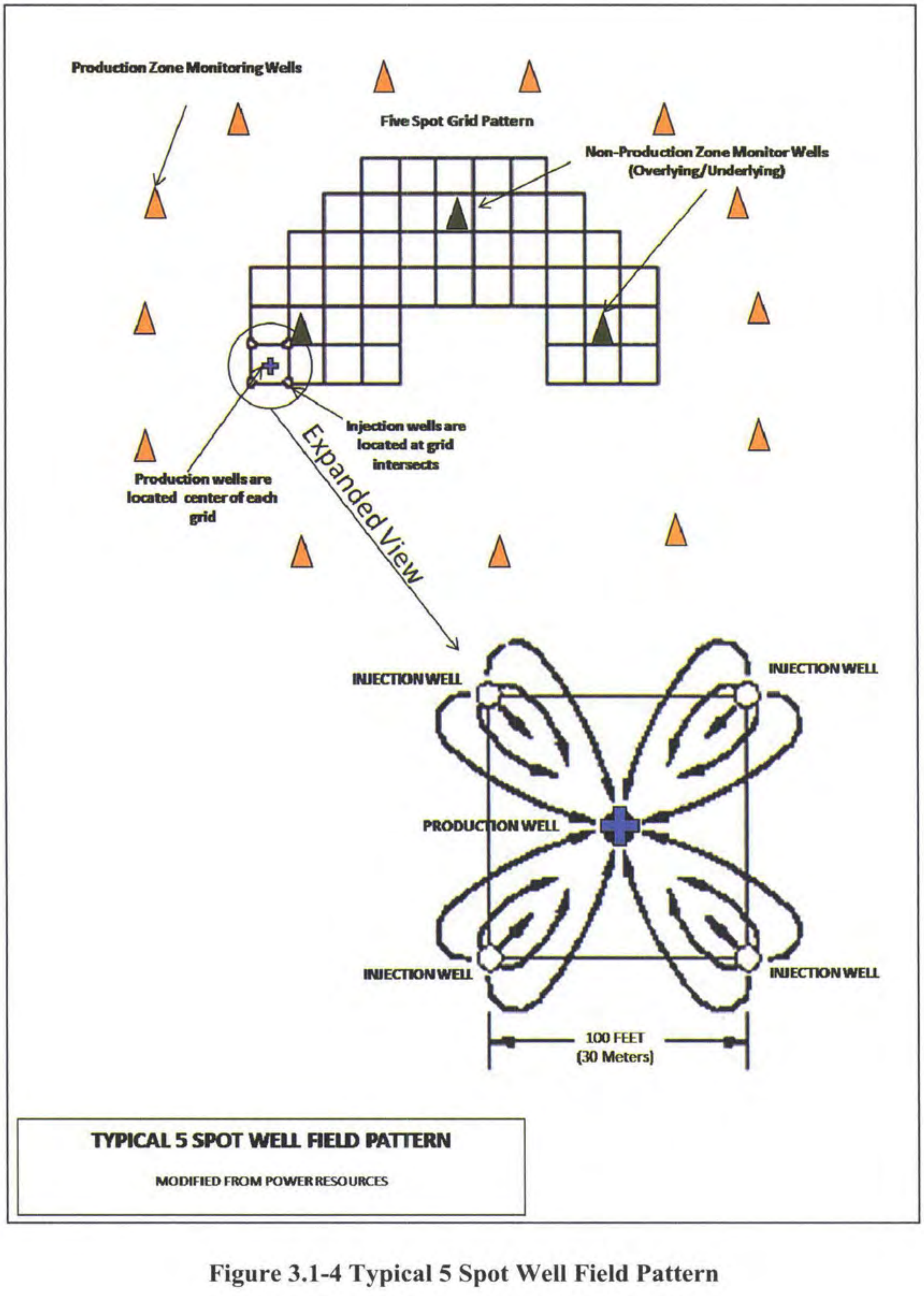

Figure 3.1-4 Typical 5 Spot Well Field Pattern

3.1.3.1 Well Field Operational Monitoring

The primary purpose of a monitoring well is to serve as an early warning system for detection of excursions and to meet the operation point of compliance (POC) in accordance with NRC's interpretations of 10 CFR Part 40, Appendix A. The proposed monitoring system is described below.

3.1.3.1.1 Non-Production Monitoring Wells

Depending on-site specific conditions, non-production monitoring wells may consist of two types of monitor wells termed "overlying" and "underlying". The screened intervals of overlying wells are located in the sand unit or aquifer immediately above the ore-bearing stratum. The overlying non-production monitoring wells are designed to provide monitoring of any upward movement of leach fluids that may occur from the production zone and to guard against potential leakage from production and injection well casing into any overlying aquifer. The overlying wells are used to obtain baseline water quality data and are used in the development of UCLs for the overlying zones that will be used to determine if vertical migration of leach fluids is occurring. Vertical monitoring is generally set up with a density of wells ranging from one every three or five acres and where confining layers are very thick and permeabilities are negligible, requirements for vertical excursion monitoring can be relaxed or eliminated for underlying aquifers (NUREG/CR-6733, 2001). The screened zone for the overlying wells is determined from electric logs by qualified geologists or hydrogeologists. The first layer of overlying non-production zone monitoring wells will be evenly distributed through the production area with a minimum of one well for every four acres of production area. Should additional aquifers exist above the first monitoring layer; additional overlying monitors will be located in these aquifers with a minimum of one well positioned for every eight acres of production area. The overlying wells will be placed within the geology just above the PAA's upper confining layer the Skull Creek Shale; it has a thickness of approximately 200 feet. Core samples were collected from the lower Skull Creek Shale; analyses of these core samples demonstrate that the Skull Creek Clays have extremely low vertical permeabilities, in the range of 6.8×10^{-9} cm/sec (0.007 millidarcies).

A single layer of underlying monitor wells may be completed in the first sand unit or aquifer underlying the ore-bearing stratum similarly based on the local lithology. The underlying monitor wells are used to obtain baseline water quality data and are used in the development of UCLs for the underlying aquifer that will be used to determine if vertical migration of leach fluids is occurring. The screened zone for the underlying monitor wells is determined from electric logs by qualified geologists or hydrogeologists. Underlying non-production monitoring wells will be evenly distributed through the production area with a minimum of one well for every four acres of production area. Underlying wells will not be installed below the Lakota formation, primarily due to the presence of the approximately 100' thick and relatively impermeable Morrison formation immediately below the Lakota formation.

Non-production zone monitoring wells will be designed and installed for detection of potential excursions of lixiviant, if such an excursion were to occur. Design of the monitor ring and overlying and underlying monitor wells will be performed for each well field according to site specific lithology and processes of the production zone(s) of each well field. Powertech (USA) will present each monitoring well program to EPA and the South Dakota Department of Environmental Natural Resources (DENR) before installation of proposed well placement to ensure administrative approval is obtained. After completion of the required hydrologic test, it may be necessary to revise the location and/or number of wells proposed. Each well field will be handled on a case-by-case basis in consultation with the EPA and DENR. Powertech's (USA) Safety and Environmental Review Panel (SERP) to be established under NRC requirements will review hydrologic test results and documentation to demonstrate that the monitoring wells are not hydrologically connected to the injection or production wells. Based on current knowledge of site lithology and processes of the production area, and industry proven practices, the number and spacing of overlying and underlying monitoring wells meets criteria to protect human health and the environment. Wells completed in overlying and underlying aquifers will be subject to sampling, remedial action, and reporting requirements pertinent to EPA and DENR rules.

The fact that the upper confining layer is approximately 200' thick and the lower confining layer is approximately 100' thick, lesson the concerns of a vertical breach for lixiviant to escape.

Approximate locations for both well types are illustrated on Figure 3.1-5 and discussed below. Additional information about sampling parameters, frequencies, and procedures is provided in Section 5 of this application.

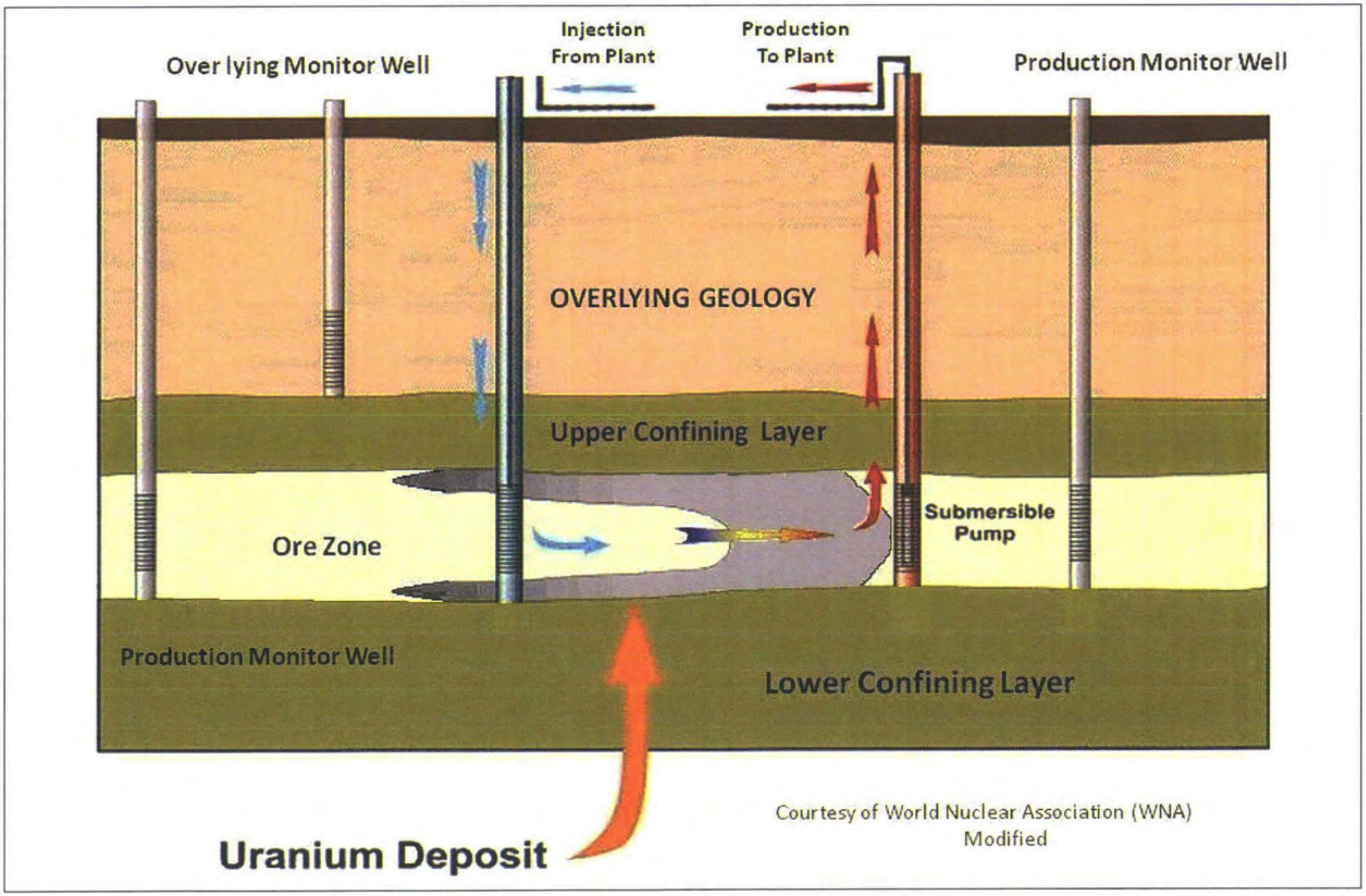

Figure 3.1-5 Cross Section of Typical Well Placement

3.1.3.1.2 Production Monitoring Wells

Production zone monitoring wells are installed around the periphery of each production area to monitor for any fluids that might escape the hydraulic controls (Hunkin, G. G., 1977 and Dickinson, K. A., and J. S. Duval, 1977), with a screened interval open to the sand unit containing the production zone. This monitoring "ring" design serves two purposes: (1) to monitor any horizontal migration of fluid within the sand unit or aquifer where production is occurring and, (2) to determine baseline water quality data and characterize the area outside the production pattern area. Upper Control Limits (UCLs) are determined from indicator constituents that are selected due to their nature of mobility to provide early warning with regards to a potential excursion; these constituents are determined from the well field specific groundwater quality baseline data. By establishing UCLs, the operator is allowed the capability of early detection of an excursion at a monitor well and then has the time to apply corrective action before water quality outside the aquifer exemption boundary is adversely affected (NUREG/CR-6733, 2001). Production zone monitor wells will be located no more than 400 feet from the production area, and will be spaced no more than 400 feet between production zone monitoring wells (NUREG/CR-6733; NUREG-1910, 2008; NUREG-1569). If the monitor wells are closer than 400 feet to the well field, the monitor wells will be located via a strategic distance to maintain a minimum angle between Monitor wells and the nearest injection well of 70 degrees. This will ensure that no leach fluids will pass between the adjacent monitor wells undetected as the leach fluids would flow radially outward from the initiation point of an excursion. Production zone monitoring wells are installed before the start of production activities in order that required baseline sampling and hydrologic tests can be conducted. Well design, construction, and development will be identical to those of injection and recovery wells, except well screens will be completed across the entire mineralized sandstone (Figure 3.1-6). Additional information about sampling parameters, frequencies, and procedures is provided in Section 5 of this application.

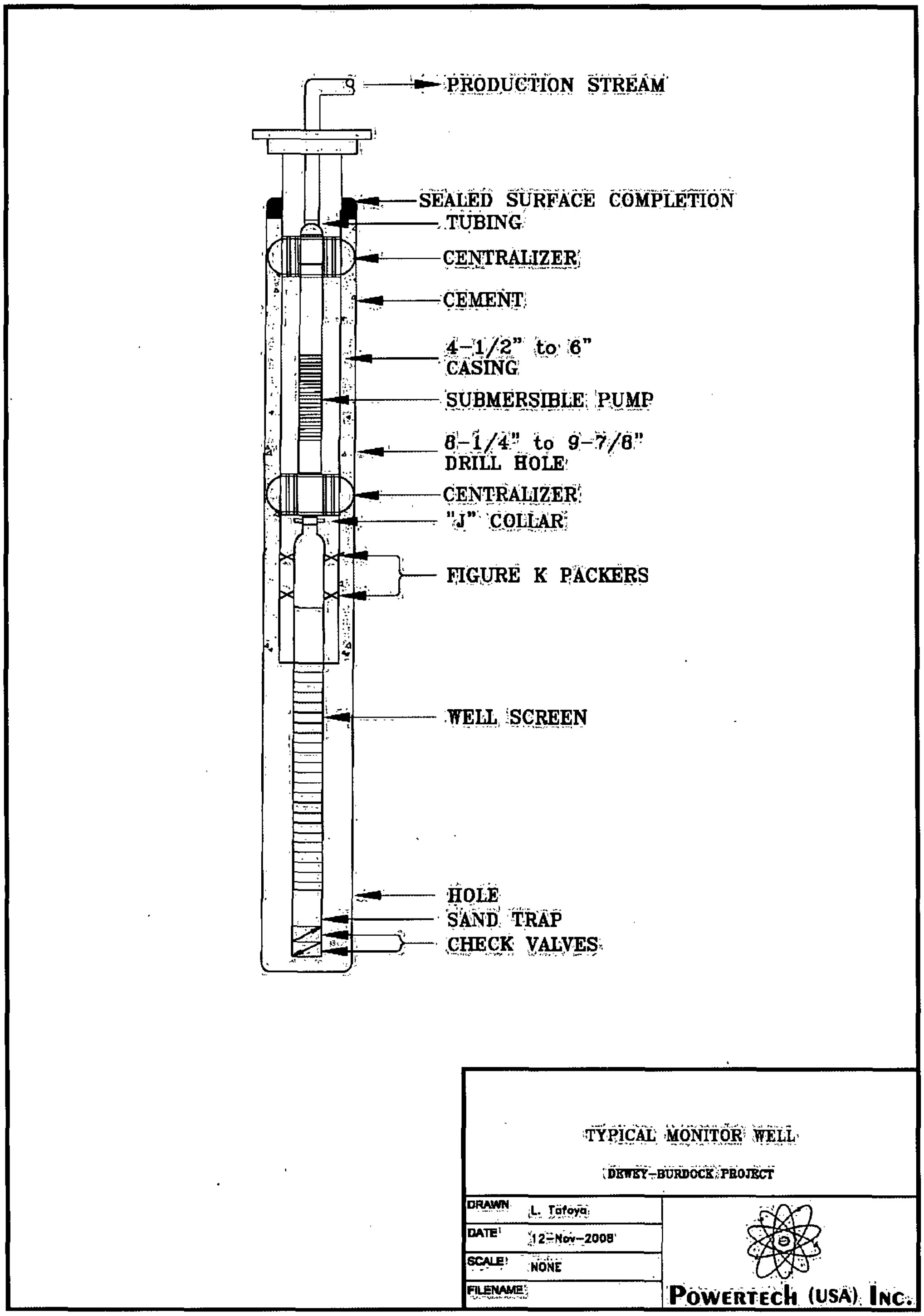

Figure 3.1-6: Typical Monitor Well Construction Diagram

3.1.4 Detection and Cleanup of Piping Leaks

Leak detection will be performed by daily visual inspection of all above-ground pipe, connections, and fittings by field personnel during their daily site visits. Operating pressures of all injection wells, recovery wells, and associated buried piping systems will also be monitored during these visits. In addition, the pressure and flow in each line will be monitored. Should pressure/flow fluctuate outside of "normal" operating ranges, the affected line will be shut down. An operator will then inspect the troubled component and determine the source of the problem. The troubled component will then be repaired, tested, and returned to service, as appropriate, and preventative measures will be implemented to prevent a recurrence.

Cleanup will involve characterizing the extent of release via visual observation coupled with sampling of soils for constituents of concern in accordance with a standard operating procedure. To the greatest extent practicable, impacted material will be consolidated into a centralized area to mitigate the potential for proliferation of small waste disposal sites within the license area. More information regarding spill management is presented in Subsection 5.7.1.3 (Spill Provision Plans) of this application.

Wastewater Disposal OptionsPowertech (USA) proposes two methods for disposal of all well field generated wastewater at the PAA. These include waste disposal well and land application with pre-treatment IX and co-precipitation of radium. The following sections discuss both wastewater disposal options.

3.1.5 Pond Design and Land Application

Ponds will be required for both options proposed. The design criterion for both systems is such that it could allow continuous disposal of 3 percent bleed as well as simultaneous operation of restoration activities.

In the case of waste disposal injection, ponds will be needed to a far lesser extent than with land application. The waste disposal well option requires ponds only for surge and temporary storage of wastewater destined for injection into the disposal well. Of the two methods, Powertech (USA) prefers to use waste disposal well, partially due to the smaller holding ponds required.

In the case of land application, storage will be required during non-application periods. One or more of these ponds will also be used to settle out radium to levels allowable for land application (Figure 2.1-1).

3.1.5.1 Pond Leak Detection

The designs of all proposed ponds consist of a dual liner system with a leak detection system (Figure 3.1-7). The primary liner and secondary liner are separated by a geonet which provides a physical separation and allows fluid flow between the two liners. The contour of each secondary liner in each pond is graded at approximately 2 percent towards a leak detection sump. Any leakage from the primary liner will be contained by the secondary liner and collected in the leak detection sump. The sump is routinely monitored for the presence of fluid on a frequency of at least once per week, if appropriate. This leak detection sump is monitored through a pipe installed within the impoundment wall. This pipe allows a submersible pump to be installed within the sump for the purpose of monitoring and/or removal of fluid should a leak occur.

Detection within the leak detection sump will initiate measures to take the pond out of use, remove its contents to another pond, and initiate an investigation into the cause of, and ultimately the repair of the condition creating the leak. The ponds are designed to be completely emptied with the use of a submersible pump.

For the land application design, the ponds have been designed to meet NRC's 10 CFR Part 40 Appendix A Criterion 5 and South Dakota Administrative Rule 74:29:11:23, pond and surface impoundment design and construction requirements (Figure 3.1-7). The ponds were sized using the industry accepted Soil-Plant–Atmospheric- Water (SPAW) estimation method (Saxton, 2006), which estimates the daily water budgets of inundated ponds and wetlands, assuming the following inflow to the ponds at each site:

1. An inflow rate, consisting of production bleed and restoration flows, of 320 gpm for 24 hours per day, 365 days per year
2. All irrigation tail water and rainfall runoff from the irrigated (land application) areas is returned to the ponds

With these design conditions, the ponds will occupy 75.31 acres and land application areas (pivot irrigation systems) will occupy 875 acres.

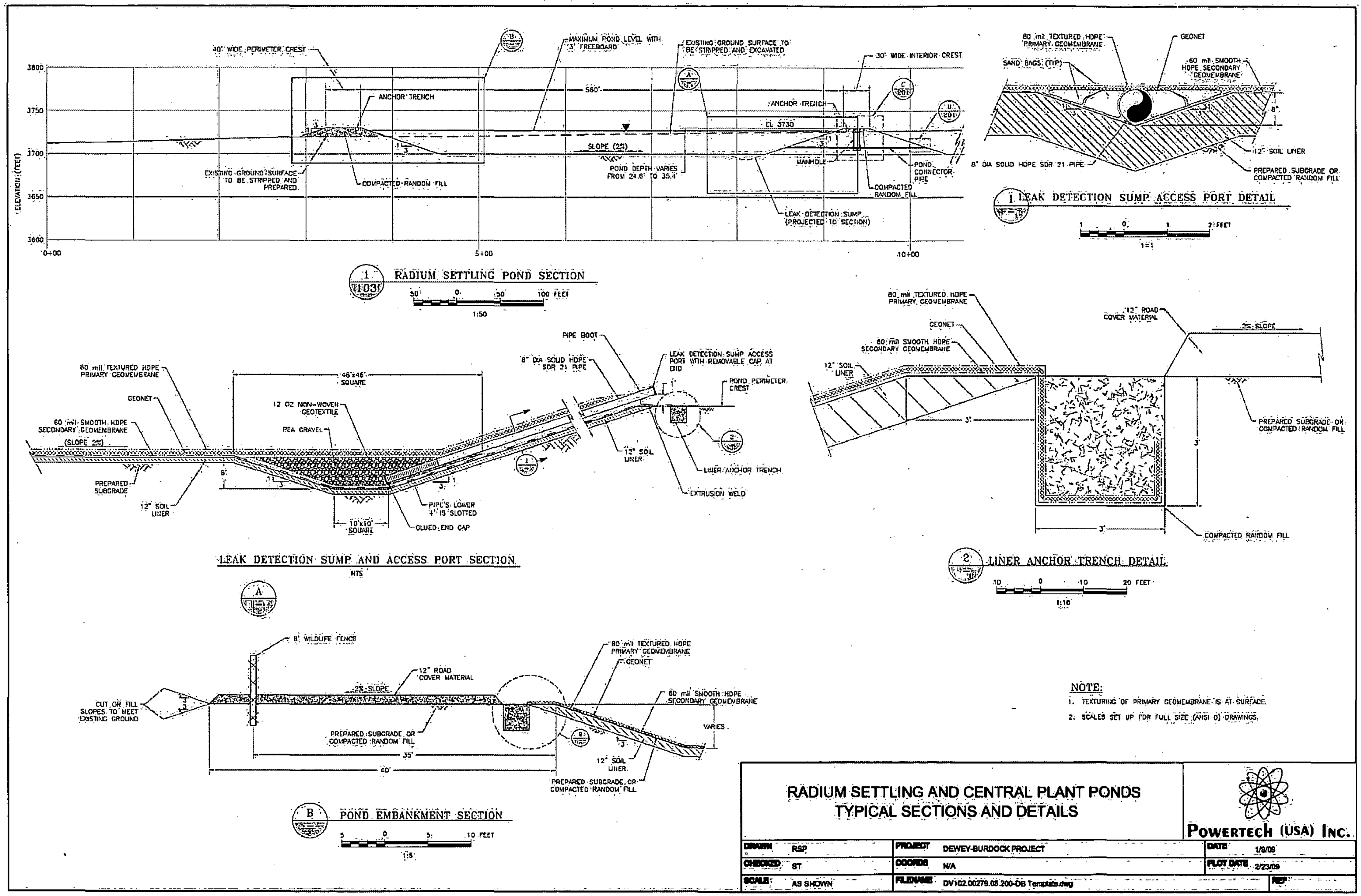

Figure 3.1-7 Typical Pond Sections Including Leak Detection

The assumed outflow from the ponds at each site is 850 gpm, 24 hours per day, 137 days per year (May 11 to September 24) during irrigation of the land application areas.

Using these assumptions, the ponds are sized to contain a volume with a one percent exceedance probability for the 15-year operating life of the facility.

Should the proposed action operate with only waste disposal well(s) as the wastewater method, a much smaller pond design is required. Sizing of this pond will be estimated upon additional design of the project but is expected to be less than 7.2 acres. Should both land application and deep disposal options be utilized, the total number and size of ponds are expected to fall somewhere between the two options. Installation of waste disposal well(s) is deemed initially feasible due to characterization of the water quality and geologic structure at and surrounding the PAA. Further analysis is in progress to determine the location of this well(s) with possibilities within the permit boundary as well as near the project boundary within Wyoming. Powertech (USA) expects that the well will be classified under a Class I or V permit.

The designs of both systems for wastewater disposal have the capacity of 3 percent bleed on a continuous basis for the life of the project. This bleed is believed to be at a minimum 2-3 times anticipated normal requirements of well field bleed in order to maintain sufficient cone of depression for operational well field control. This design criterion is believed to be highly conservative since it is not expected that the project will reach the full capacity of wastewater disposal systems (Figure 3.1-7).

3.1.5.2 Waste Disposal Well

Under the waste disposal well option would be conducted in Wyoming. The Area Permit would consist of four WDWs. A dedicated pipeline, approximately six miles long will be constructed to connect the site to the well field.

Under the WDW option, an offsite waste disposal well, located in Burns, Wyoming will be used for disposal of brine wastes from the Dewey CPP. Wastewater will be transported by tanker truck from the facility to the WDW.

Figure 3.1-8 provides the facilities map depicting the waste disposal well option.

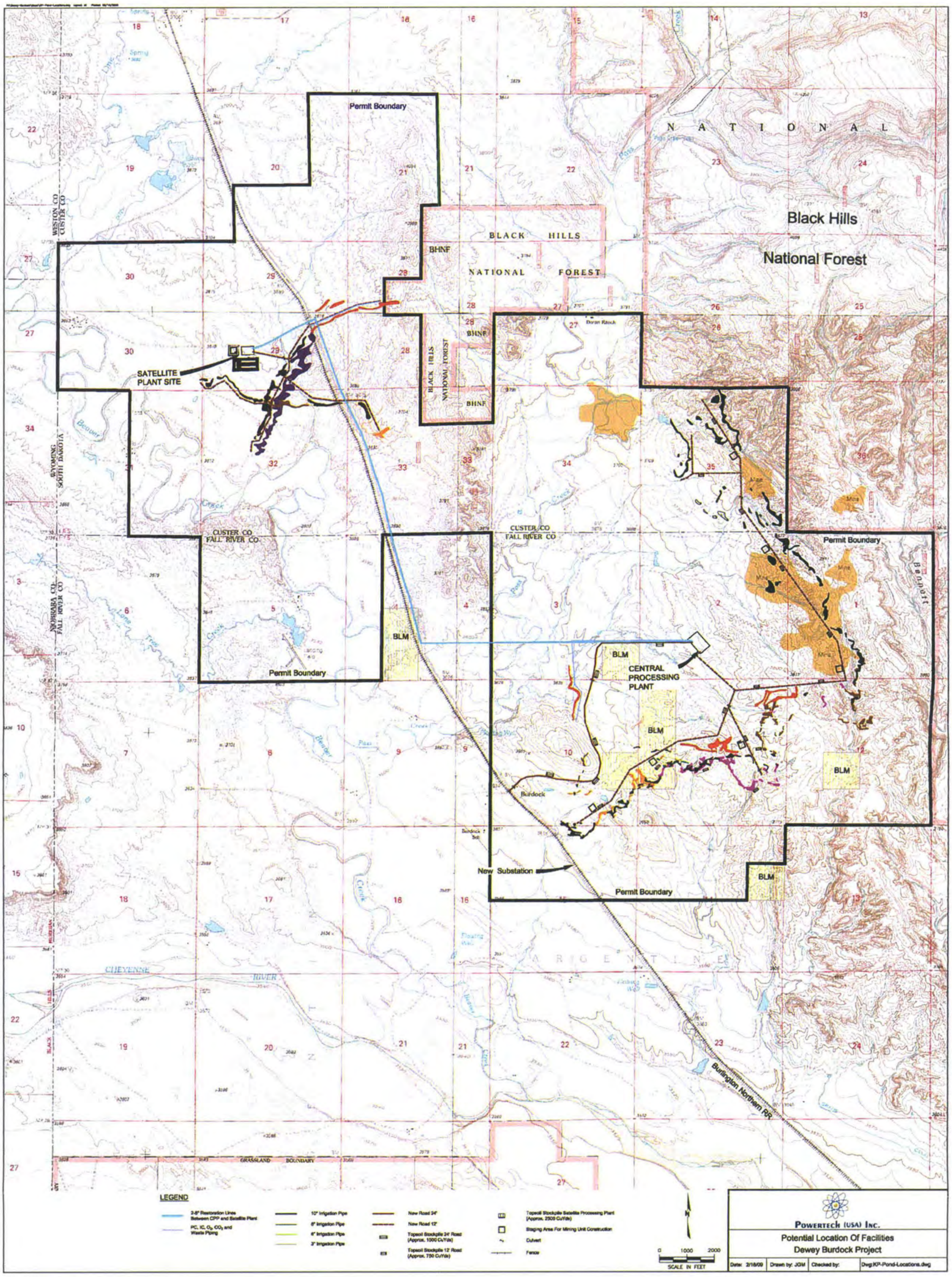

Figure 3.1-8: Facilities Map with Waste Well Disposal

3.1.6 Surface Water Management

All of the Dewey-Burdock facilities are located outside of the FEMA 100-year flood plain as discussed in Section 2.7.1.4.4.

For well fields and non-CPP/SF areas, stormwater management will include general grading of roads and building pads to promote positive drainage toward existing water courses. Best management practices (BMPs) for sediment control during construction and operations will be provided until vegetative cover on disturbed ground has been restored. Such practices will include, but not be limited to, use of silt fences and hay bales downstream of disturbed areas, and as necessary, long-term erosion protection using stream channel armoring such as rip rap, gabions, and/or geotextiles.

For the CPP site area, SF site, and contiguous impervious services, excess runoff above pre-existing conditions will be temporarily detained to assure that peak runoff flow following construction does not exceed peak runoff flow prior to construction. BMPs will include construction of bermed parking lots with controlled outlet structures, routing flow into stormwater detention ponds with controlled outlet structures, or some combination thereof. In addition, sediment control during construction will be accomplished using similar BMPs.

Surface water/groundwater interactions and potential impacts to these media from site activities are discussed in Section 7 of this application.

3.1.7 Quality Control

Quality Control during construction, operations, and reclamation will be assured through strict compliance with construction plans and specifications, operations manuals, and standard operating procedures. During construction, quality will be assured through material testing programs prescribed in the specifications, review of testing results by the design engineer, and inspection and acceptance of work products by the owner's representative.

During operations, standard operating procedures developed during project design will be followed. Operations supervisors will instruct field personnel as to the documented procedures and routinely inspect and document their performance.

3.1.8 Approved Waste Disposal Agreement for 11e.(2) Material

Prior to engaging in licensed ISL operations, Powertech (USA) will supply a waste disposal agreement with an NRC approved facility for the disposition of solid 11e.(2) materials.

3.2 Central Processing (CPP) and Chemical Storage Facilities; Equipment Used and Material Processed

One SF will be located at the Dewey site and a combination SF/CPP will be located at the Burdock site (Figure 3.2-1). The downstream uranium recovery processes described in the preceding section will be accomplished in several steps. Uranium recovery from the solution by IX, subsequent processing of the loaded IX resin to remove the uranium (elution), the precipitation of uranium, thickening of the uranium slurry, and the dewatering, drying, and packaging of solid uranium oxide (yellowcake) will be performed at the CPP.

The sites for both the CPP and the SF have been designed to provide security and ease of access for operating purposes. The sites are designed with ample areas for access by resin transfer trucks as well as truck transports for chemical delivery and shipment of product and byproduct materials. Figure 3.2-2 shows the site layout of the CPP site, including the placement of an office building, a maintenance shop and the CPP proper. Traffic routes and truck turning radii are indicated on this figure. The site layout for the SF is shown in Figure 3.2-3.

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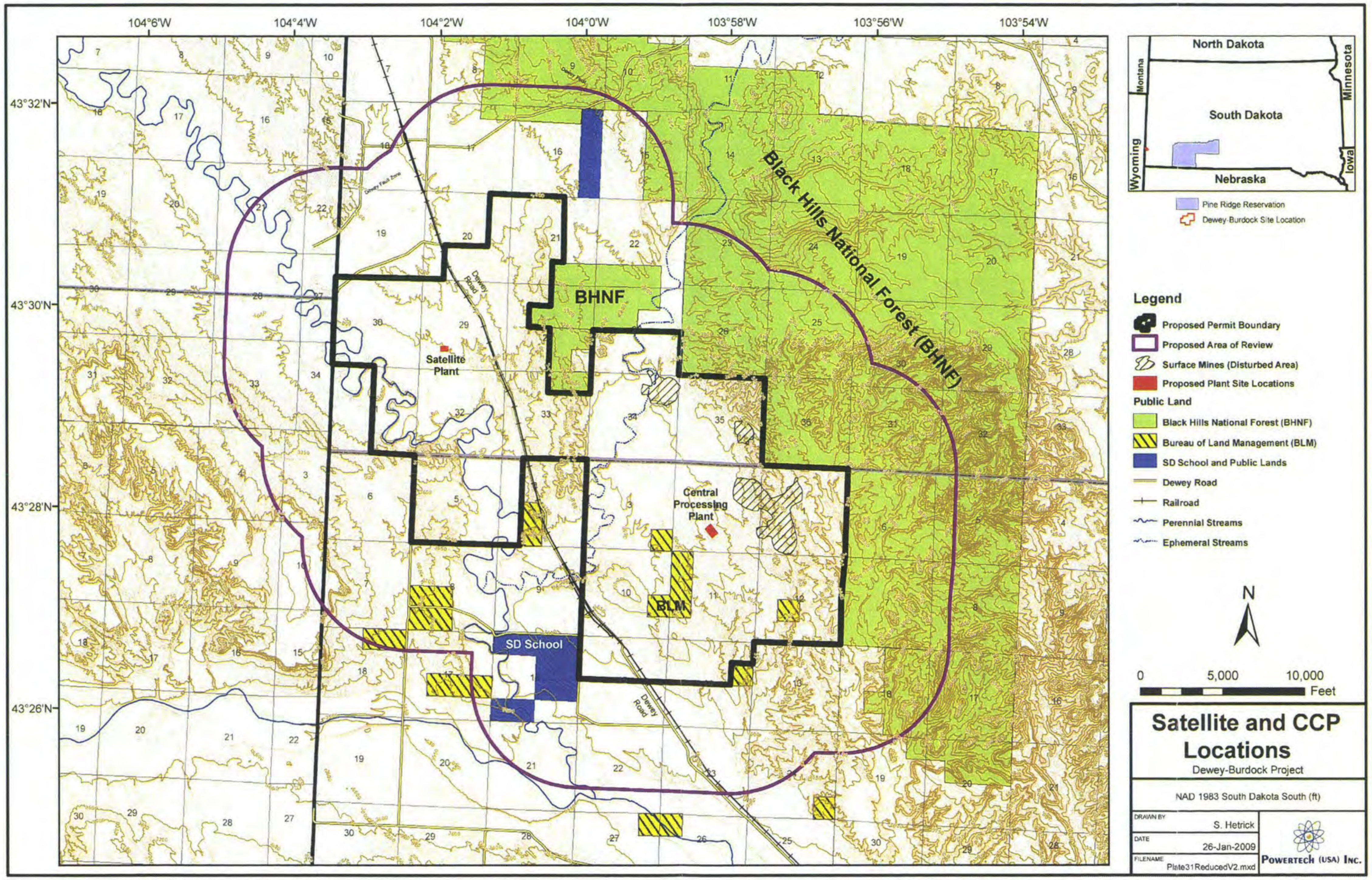

Figure 3.2-1: Proposed Locations for the Satellite Facility and Central Processing Plant

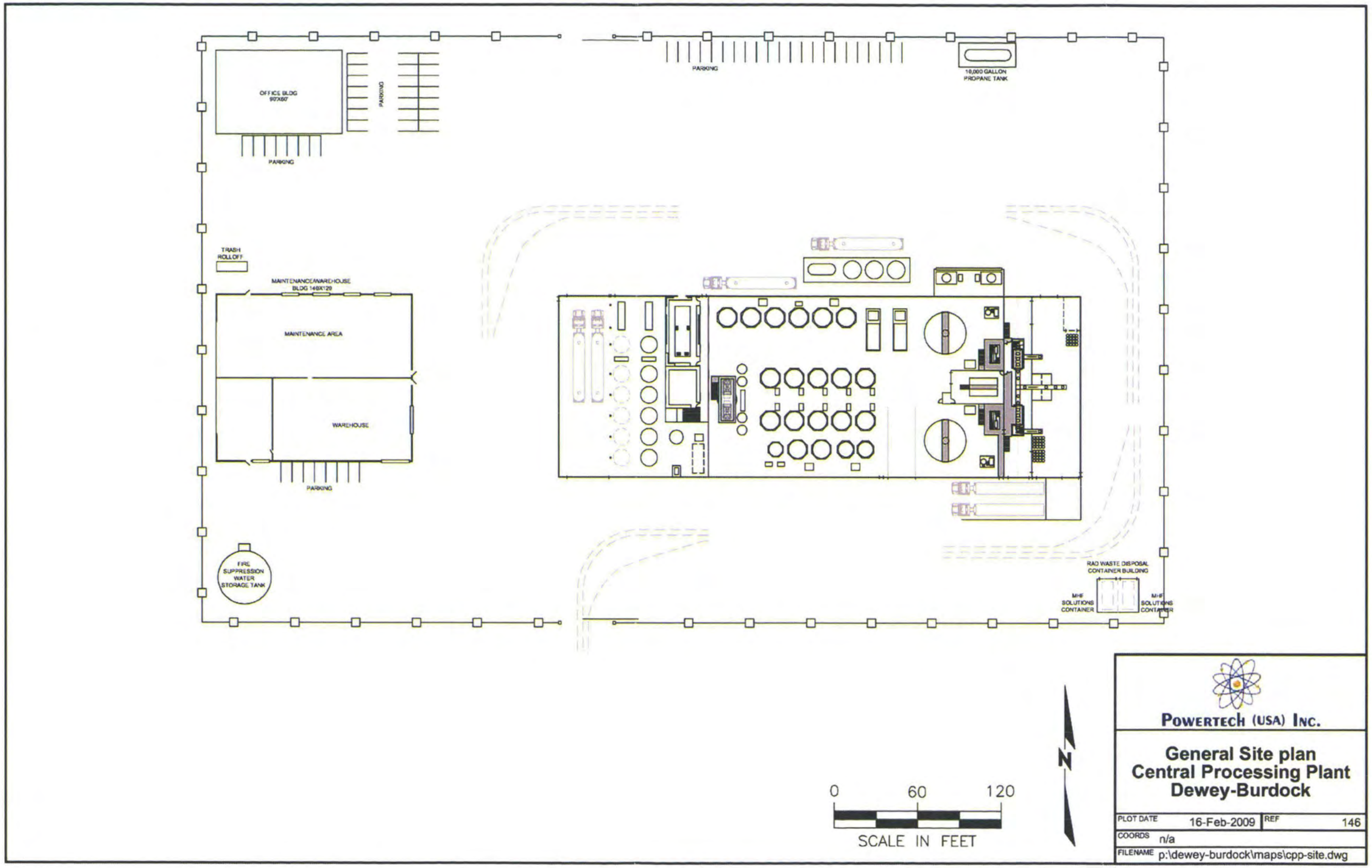

Figure 3.2-2: General Site Plan Central Processing Plant

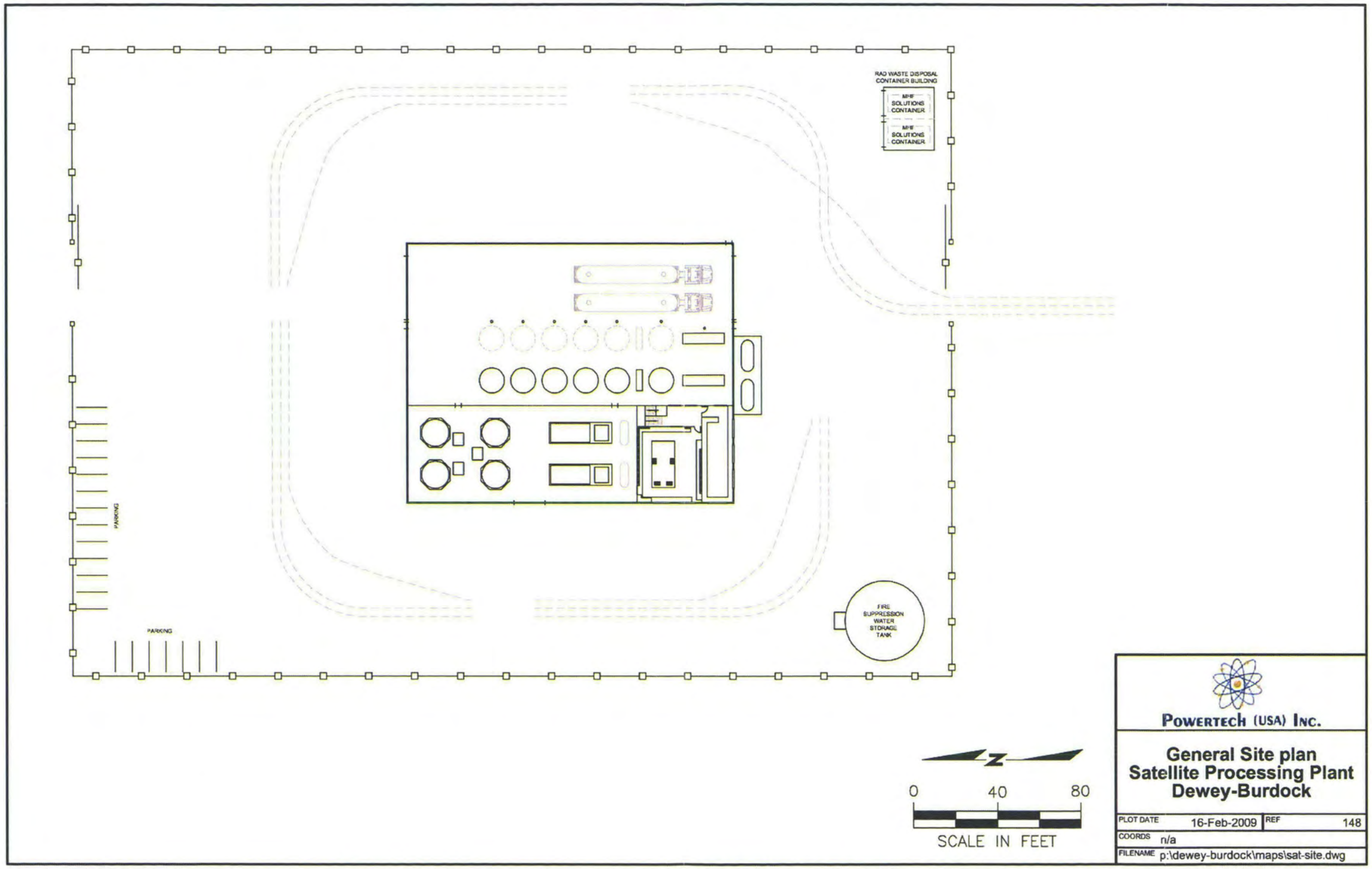

Figure 3.2-3: General Site Plan - Satellite Facility

3.2.1 CPP Equipment

The processing facilities will be housed in pre-engineered metal buildings. The equipment layout within these buildings is shown in Figures 3.2-4 and 3.2-5 for the CPP and SF, respectively. The CPP includes the following:

- IX
- Chemical addition
- Filtration
- Elution circuit
- Precipitation and thickening circuit
- Product dewatering, drying and packaging
- Liquid waste stream circuit
- Drum storage and decontamination area
- Waste Storage buildings are located at the SF in Dewey and the CPP area at Burdock.

Based on preliminary design and site geotechnical evaluations, the project CPP will be located within Section 2, T7S, R1E. Chemical storage and a septic tank and leachfield will also be located within this area. The Dewey SF will be located in Section 29, T6S, R1E. These plant locations are shown in Figure 3.2-1.

The CPP will serve production from Dewey-Burdock ISL operations, and possibly resin from other potential Powertech (USA) satellite projects in the area. In addition, depending on market conditions and regional demand for yellowcake processing, the CPP may be used for tolling arrangements with other ISL operations licensed under a different operator.

The following subsections present a description of each recovery and processing system and the equipment components comprising each system. An overall process flow diagram is presented in Figure 3.2-6.

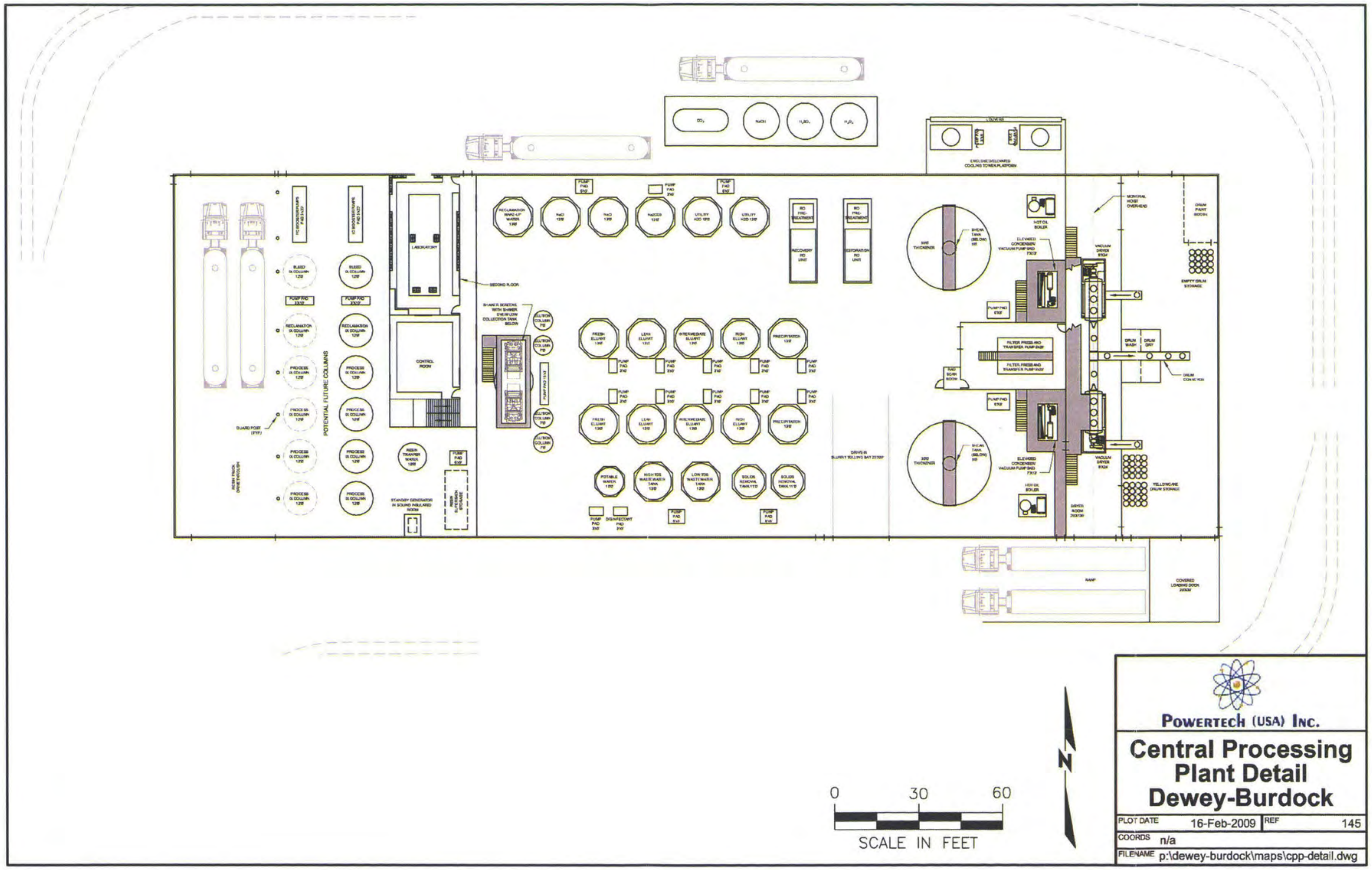

Figure 3.2-4: Central Processing Plant Detail

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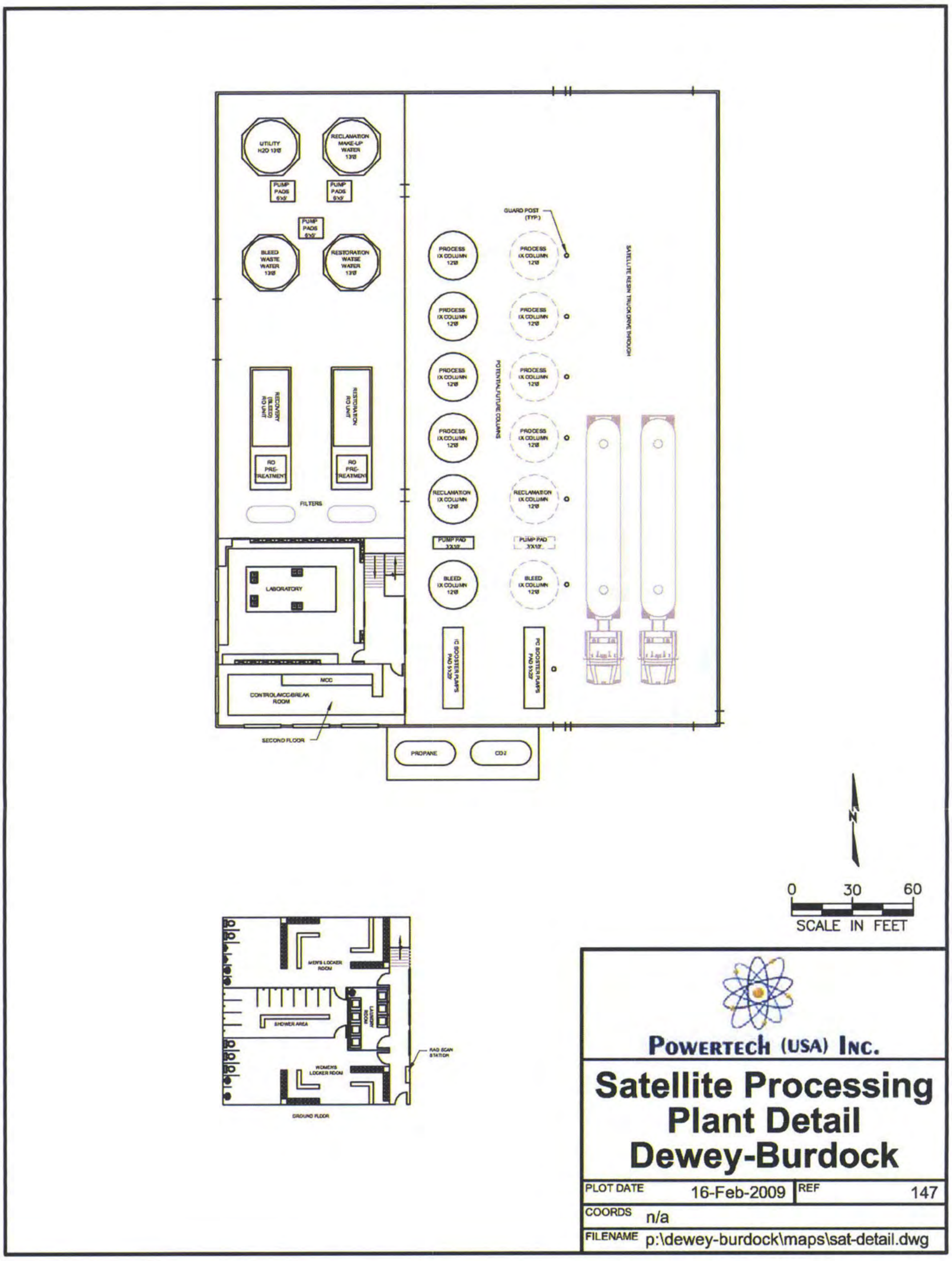

Figure 3.2-5: Satellite Facility Plant Detail

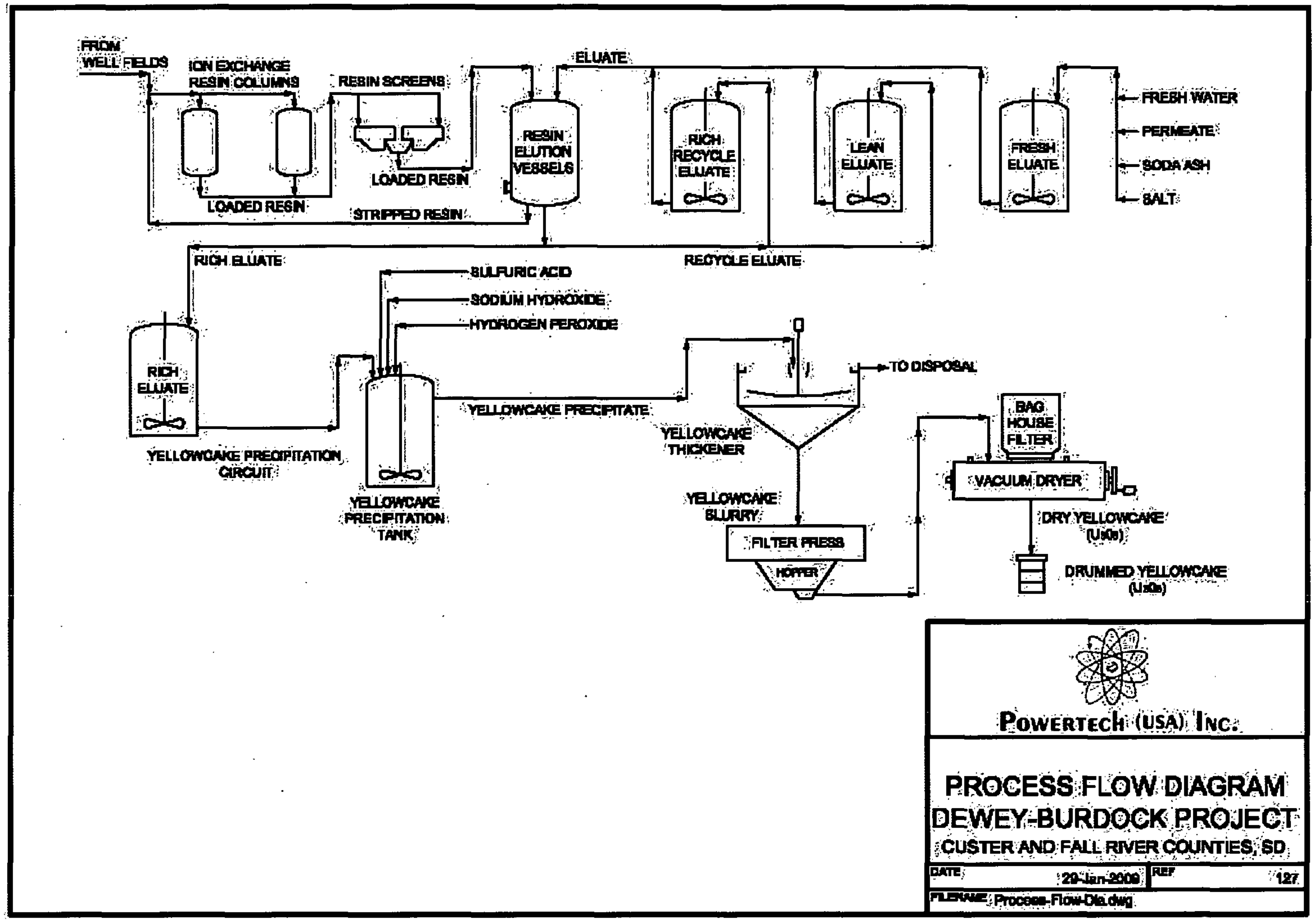

Figure 3.2-6: Overall Process Flow Diagram

3.2.2 Recovery

Recovery of the uranium from the uranium bearing or pregnant lixiviant solution will be accomplished via an ion exchange process. The pregnant lixiviant from the well field will be pumped through IX vessels containing uranium-specific IX resin beads (Dowex 21K XLT or equivalent). As the lixiviant flows through the resin beds, the complexed uranium molecules attach themselves to the beads of resin, displacing a chloride ion or bicarbonate ion as shown below:

$$2\,RCl + UO_2(CO_3)_2^{-2} \rightarrow R_2UO_2(CO_3)_2 + 2Cl^{-1}$$

$$2\,RHCO_3 + UO_2(CO_3)_2^{-2} \rightarrow R_2UO_2(CO_3)_2 + 2HCO_3^{-1}$$

Each resin bead has a finite number of sites where the uranium complex can attach. When most of the available sites in the resin bed are occupied by uranyl dicarbonate (UDC) or uranyl tricarbonate (UTC) ions, the resin will be considered to be "loaded" and will be ready for processing.

The IX vessels will be designed to operate in downflow mode, and each will contain approximately 500 ft^3 of IX resin. The IX vessels will be arranged in multiples of two vessels in series. The lixiviant will be passed through the primary or lead vessel which will be where most of the resin loading takes place. The lixiviant will then pass through the secondary or lag vessel where the solution will be "polished" by removal of any remaining dissolved uranium. When the lead vessel becomes loaded, it will be taken off line and flow of lixiviant will be routed to the secondary vessel which will become the lead vessel. The resin in the off-line vessel will be removed and regenerated resin will be returned to the vessel. The vessel containing the regenerated resin will be then brought back on line in the lag position. The resin that was removed will be transferred to the elution and regeneration process in the CPP.

After passing through the IX vessels, the barren lixiviant will be returned to the well field where oxygen and carbon dioxide will be added prior to reinjection. A booster pump station may be required to achieve the required injection pressure. A sidestream referred to as the production bleed will be removed from the barren lixiviant and routed to either the wastewater system or the production bleed reverse osmosis (RO) system, depending on which operating option, A or B as discussed in section 3.1.5, is utilized. The flowrate of this sidestream will be approximately 0.5 percent to 3 percent of the pregnant lixiviant flowrate. The purpose of the production bleed stream is to maintain a hydraulic gradient towards the mine unit well field, as discussed in Section 3.1.

3.2.2.1 Recovery Equipment

The recovery equipment includes the recovery IX vessels, the production bleed reverse osmosis system (land application option only), and the recovery and injection composite booster pumps.

Ion Exchange Vessels

The IX columns will be vertical cylindrical pressure vessels with dished heads. The vessels will be constructed of fiberglas-reinforced plastic (FRP), and will be approximately 13 feet in diameter with a seam to seam height of 8 feet. The vessels will be constructed according to American Society of Mechanical Engineers (ASME) Section VIII specifications. Each vessel will be equipped with an upper flow distribution plate and a lower flow distribution manifold constructed of stainless steel pipe and slotted well screen. The IX vessels will be designed to provide optimum contact time between pregnant lixiviant and IX resin. These vessels can be operated at a wide range of flowrates without loss of performance.

At both the SFs and the CPP, the air/vacuum relief valves on the IX columns will be piped together in a manifold which will be vented above the roofline of the building. In addition, a flexible duct designed to attach to tanker trucks during loading and unloading of resin will be connected to this vent manifold. This vent system will not have a fan because vacuum relief requires an inflow of air.

Each vessel will be equipped with a pressure relief valve and an air/vacuum release valve. Pressure transmitters and pressure gauges on the inlet and outlet piping connected to each vessel will measure and indicate pressure both locally and in the control room. Control interlocks with the well pumps and booster pumps will be used to prevent system pressure from exceeding the pressure rating of the lowest rated system component.

Production Bleed RO System (WDW Option)

The production bleed RO system will be designed to accommodate the production bleed flow, rejecting approximately 30 percent of the flow as brine and returning 70 percent of the flow as permeate. The production bleed RO system will be a packaged system including feed conditioning, filtration, membranes, and control system.

Booster Pumps

Booster pumps may be used to convey pregnant lixiviant to the SF or CPP, and to convey barren lixiviant from the SF or CPP to the well field. These pumps will be in-line centrifugal pumps, and will each have the capacity to pump 50 percent of the design flow. The pumps will be equipped with pressure indicators on the discharge lines, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room located in the SF or CPP, respectively. The measured flow will be used to control pump motor speed via a variable frequency drive.

3.2.3 Resin Transfer

Resin will be transferred out of IX vessels at the CPP and SF to the elution circuit where it will be regenerated by contacting it with concentrated salt solutions. The concentrated salt solution displaces the UDC and UTC and replaces them with chloride or carbonate ions. The regenerated resin will be then transferred back to IX vessels.

At the CPP, resin transfer will be accomplished by pumping water into the top of the IX vessel with the bottom discharge valve open. This will force the resin to flow out of the vessel into the transfer pipe. The resin and water will be pumped via the transfer piping to one of two elevated shaker screens. The shaker screens will be inclined, vibrating screens which will separate transfer water, loaded resin, and waste into separate streams. The transfer water will pass through the screens and flow by gravity into a collection tank which feeds the resin transfer pumps. The loaded resin will drop into one of four elution columns to be regenerated. The oversized or undersized solid waste from the shaker screens will consist of broken resin beads, silt and sand from the wells, and scale removed from the resin, and will collect in a hopper to be periodically removed and drummed for disposal.

Following elution of the resin, the transfer process will be reversed. Water will be pumped into the top of the elution column with the bottom discharge valve open. This will force the resin out of the column and into the resin transfer piping. The resin and water will be pumped back to the IX vessel where they will enter through a nozzle on the side of the vessel. The resin transfer water will exit the vessel through the bottom liquid distributor and flow back to the resin transfer water tank. The resin will remain in the IX vessel because it will not be able to pass through the screen openings in the bottom liquid distributor.

At the SFs, loaded resin will be transferred from the IX vessels to a tanker truck that enters the building (Figure 3.2-5). Resin transfer will be accomplished through resin transfer piping and hoses that connect the exchange vessels to the transfer truck. With the connections made and transfer valves opened, resin transfer water will be pumped into the top of the IX vessel with the bottom discharge valve of the vessel open. This will force the resin to flow out of the vessel and into the tanker truck. Water and resin will enter the tanker, and water will exit the tanker through a screened outlet port and be returned to the resin transfer water tank. The resin, which cannot pass the screen, will remain in the tanker. When the resin has been flushed from the vessel and piping, the excess transfer water is drained from the truck, the valves controlling the transfer will be closed and the hoses disconnected from the truck.

The truck will then transport the resin to the CPP where the truck will be connected via hoses to the resin transfer water headers. To transfer resin out of the tanker, water will be introduced to the tanker from the resin transfer water tank, and water and resin will flow out of the tanker to the vibrating screens described above. To transfer resin back into the tanker following elution, water and resin will be pumped out of the columns as described above, and routed into the tanker via the hose connections between the tanker and the resin transfer header. As with the transfer at the SF, the resin will remain in the tanker and the transfer water will return to the resin transfer water tank. When the tanker returns to the SF, the regenerated resin will be transferred back into the IX vessel using the same methods.

3.2.3.1 Resin Transfer Equipment

Equipment associated with the resin transfer system includes a resin transfer tanker truck, two shaker screens, a shaker screen water tank, a resin transfer water tank, and a resin transfer pump.

Resin Transfer Tanker Truck

Resin transfer tanker trucks will have one or more compartments with sloped bottoms and screened bottom outlet nozzles. Resin transfer tanker trucks will have a minimum capacity of 500 ft3 per compartment.

Shaker Screens

The shaker screens will be packaged units that allow adjustment of angle and motion to optimize separation. The screens will be installed on an elevated platform to allow resin to drop into the elution columns. Hoods will be constructed above each shaker screen. Each hood will be connected to a vent header that will exhaust through a vent stack in the building roof to prevent radon accumulation inside the CPP.

Shaker Screen Water Tank

The shaker screen water tank will be a vertical cylindrical atmospheric tank with a cone bottom and flat cover. The tank will be constructed of fiberglass reinforced plastic (FRP) and will be elevated to allow gravity flow of water into the resin transfer water tank from the shaker screen. Waste solids from the resin transfer process will collect in the conical bottom of the tank and will be removed periodically and disposed. The tank will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room. The tank will be connected to a vent header which will exhaust through a vent stack on the building roof.

Resin Transfer Water Tank

The resin transfer water tank will have a capacity of approximately 12,000 gallons. This tank will be a vertical cylindrical atmospheric tank with a flat bottom and flat cover. The tank will be constructed of FRP, and will be approximately 13 ft in diameter with a height of 13 ft. The tank will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room. The tank will be connected to a vent header which exhausts through a vent stack on the building roof.

Resin Transfer Water Pump

The resin transfer water pump will have a capacity of approximately 300 gpm. This pump will be a horizontal, end-suction centrifugal pump and will be constructed of ductile iron. The pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

3.2.4 Elution

The elution process will remove the UDC and UTC from the resin and restore the resin to its chloride form to allow it to be put back into service to remove uranium from pregnant lixiviant. This process is represented by the following equations:

$R_2UO_2(CO_3)_2 + 2Cl^- \rightarrow 2\ RCl + UO_2(CO_3)_2^{-2}$

$R_4UO_2(CO_3)_3 + 4Cl^- \rightarrow 4RCl + UO2(CO_3)_3^{-4}$

Elution will be a four-stage process that takes place in an elution column and will involve contacting the loaded resin with batches of eluant solution containing approximately 10 percent by weight sodium chloride and 2 percent by weight sodium carbonate. Each elution stage will strip the resin of additional uranium complex and further restore the exchange capacity of the resin. Following the final elution stage, more than 95 percent of the uranyl carbonate complex will have been removed from the resin.

In the first elution stage, intermediate eluant will be pumped from the intermediate eluant tank through the elution column, stripping approximately 80 percent of the uranyl carbonate ions from the resin. After exiting the column, this solution will be pumped into the rich eluate tank.

In the second elution stage, lean eluant will be pumped from the lean eluant tank through the elution column, stripping approximately 60 to 70 percent of the remaining uranyl carbonates from the resin. After exiting the column, this solution will be pumped into the empty intermediate eluant tank to be used as intermediate eluant in the processing of the next batch of loaded resin.

In the third elution stage, fresh eluant will be pumped from the fresh eluant tank through the elution column, stripping approximately 30 to 40 percent of the remaining uranyl carbonate ions from the resin. After exiting the column, this solution will be pumped into the lean eluant tank to be used as lean eluant in the processing of the next batch of loaded resin.

In the fourth and final elution stage, utility water will be pumped from the utility water tank through the elution column, displacing the eluant entrained in the resin. After exiting the column, the rinse water will be pumped into the fresh eluant tank. Saturated sodium chloride and sodium carbonate solutions will be pumped into the fresh eluant tank to make up the next batch of fresh eluant.

3.2.4.1 Elution System Equipment

Elution system equipment includes four elution columns, eight eluant/eluate tanks, and elution pumps.

Elution Columns

The four elution columns will be vertical cylindrical pressure vessels with dished heads. The vessels will be constructed of FRP. The vessels will be constructed according to ASME Section VIII specifications. Each vessel will be equipped with upper and lower flow distribution manifolds constructed of stainless steel pipe and slotted well screen. The elution columns will be designed to provide optimum contact time between eluant solutions and IX resin. These columns will be capable of being operated over a range of flowrates without loss of performance.

Each column will be equipped with a pressure relief valve and an air/vacuum release valve. Each column will also be equipped with a level indicator/transmitter which will measure and indicate level in the column both locally and in the control room. Pressure transmitters and pressure gauges on the inlet and outlet piping connected to each vessel will measure and indicate pressure both locally and in the control room. Each tank will be connected to a vent header which exhausts through a vent stack on the building roof to minimize radon emissions within the CPP building.

Elution Tanks

There will be a total of 8 elution tanks in the CPP. These include two Fresh Eluant Tanks, two Lean Eluant Tanks, two Intermediate Eluant Tanks, and two Rich Eluate Tanks. Each elution tank will have a capacity of approximately 16,500 gallons. Each tank will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room. Each tank will be connected to a vent header which will exhaust through a vent stack on the building roof to prevent radon accumulation inside the CPP building.

Elution Pumps

There will be a total of 10 elution pumps, each with a capacity of approximately 150 gpm. These pumps will be horizontal, end-suction centrifugal pumps and have wetted parts constructed of FRP. Each pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

3.2.5 Precipitation

The precipitation process will be designed to break the uranyl carbonate complex, precipitate the uranium as uranium peroxide, and settle the precipitated solids from the eluant solution. The precipitation process will be comprised of a series of chemical addition steps, each causing a specific change in the rich eluate solution.

Prior to beginning the precipitation process, the rich eluate transfer pump will be used to transfer the rich eluate from the rich eluate tank to the precipitation tank. The precipitation tank contents will be mixed via an agitator. The first stage of chemical addition will be to add sulfuric or hydrochloric acid to bring the pH down to a range of approximately 2-3 pH units. This change in pH will cause the uranyl carbonate complex to break, liberating carbon dioxide, which will be vented from the tank, as illustrated in the following chemical reaction.

$$UO_2(CO_3)_3^{-4} + 6H^+ \rightarrow UO_2^{++} + 3\ CO_2\uparrow + 3H_2O$$

Following completion of CO2 evolution, sodium hydroxide will be added to raise the pH of the solution to between 4 and 5 pH units. When the pH has stabilized, hydrogen peroxide (H2O2) will be added to the solution to form insoluble uranium peroxide (UO4). Following addition of H2O2 , the agitator speed will be slowed down to promote crystal growth.

$$UO_2^{++} + H_2O_2 + 2H_20 \rightarrow UO_4 \bullet 2H_2O + 2H^+$$

After a precipitation period of up to 8 hours, sodium hydroxide will be added to raise the pH to approximately 7, and the contents of the precipitation tank will be pumped into the thickener using the precipitation transfer pumps.

3.2.5.1 Precipitation System Equipment

Precipitation system equipment will include precipitation tanks, transfer pumps, and thickeners.

Precipitation Tanks

There will be two precipitation tanks in the CPP. Each precipitation tank will have a capacity of approximately 20,000 gallons. Each tank will be a vertical cylindrical atmospheric tank with sloped bottom and flat cover. Each tank will be constructed of FRP. Each tank will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room. Each tank will be equipped with a pH sensor connected to a pH indicator/controller in the control room. Each tank will be connected to a vent header which will exhaust through a vent stack on the building roof to prevent radon accumulation inside the CPP building.

Thickeners

There will be two gravity thickeners in the CPP. Each thickener will be a rubber lined 30-ft. diameter steel tank with conical bottom. The thickeners have a rake mechanism which has angled arms that match the angle of the conical bottom of the tank. As the rake rotates, the motion of the paddles through the sludge blanket at the bottom of the thickener will express liquid out of the sludge and increases the solids content of the sludge. The liquid and suspended solids from the precipitation tank will be introduced into the thickener via a center feed tube. The suspended solids will settle out of the liquid as it flows from the center of the thickener to the side overflow launders. Clarified effluent will spill over a weir into the launders, and from there it will be collected and directed to the solids removal tank in the wastewater system.

Precipitation Transfer Pumps

There will be 2 precipitation transfer pumps, each with a capacity of approximately 200 gpm. Each pump will be a horizontal, end-suction centrifugal pump and has wetted parts constructed of FRP. Each pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room.

Pressure Filtration

The pressure filtration system will be designed to dewater, rinse, and air dry the precipitated uranium peroxide present in the thickener underflow. The thickener underflow will be pumped by progressive cavity pumps into the two horizontal plate and frame filter presses where the solids content of the thickener underflow will be increased to approximately 60 percent by weight by first pressing the slurry between filtration diaphragm plates. Then the press pressure will be released and utility water will be pumped through the filter cake to remove impurities, particularly chloride. The plates will then be pressed again, followed by introducing compressed air to the pressed cake to further dry it. Upon completion of the drying cycle, the filter cake will be conveyed out of each filter chamber on the moving filter cloth and directed into the two filter press cake chutes. An enclosed inclined screw conveyor will convey the filter cake from the shoot to the feed inlet on one of the two vacuum dryers.

Wastewater exiting the filter press will flow into a sump and be pumped into the solids removal tank in the wastewater system.

In order to minimize the potential for fugitive dust particles, the filter presses will located in a separate room and each will be enclosed in an interlocked cover. The connections between the cake chutes and enclosed screw conveyors will be gasketed and flanged, the screw conveyors will be enclosed, and the connection between each screw conveyor and knife gate valve on the dryer feed inlet will be gasketed and flanged. HVAC considerations for this system are discussed in Section 3.2.11 below.

The filter presses will be equipped with pressure gauges that indicate the pressure in the hydraulic system, as well as an inlet pressure indicator transmitter. Inlet pressure will be interlocked with the feed pumps to prevent over-pressurization of the filter presses.

3.2.6 Drying and Packaging

The uranium peroxide filter cake will be dried in a rotary vacuum dryer at approximately 450°F. Angled paddles attached to a central shaft in the dryer will agitate the filter cake to promote even drying. The dryers will be heated with a thermal fluid (e.g., MultiTherm IG-4) that will be circulated through the dryer shell and the rotating central shaft. The thermal fluid (TF) will be heated by an electric heater with a pump for circulating the TF through the shell and central shaft of the dryer.

The vapor pulled from the dryer by the vacuum pump will be filtered through a baghouse filter located on the top of the dryer to remove particles down to approximately 1 micron in size. The vapor exiting the baghouse will be cooled using a condenser to remove water vapor and remaining small particles. Liquid ring vacuum pumps will provide the vacuum source. The water that will be collected from the condenser will be pumped to the solids removal tank in the wastewater system.

Two rotary vacuum dryers, baghouses, and packaging equipment will be housed in a separate room in the CPP. The vacuum pump and condenser system for each dryer, and the TF heaters and pumps will be located in the main CPP area to provide access for operation and maintenance. The vacuum pumps will discharge to the dryer room. Air in the dryer and packaging room will be monitored routinely for airborne dust. A dedicated air handler equipped with HEPA filters will ventilate the dryer and packaging room and will provide an additional level of controlling particulate emissions.

3.2.6.1 Drying and Packaging Equipment

The major components of the system include the vacuum dryers, baghouses, vacuum pump and condenser systems, thermal fluid heaters, and the packaging system.

Vacuum Dryer

There will be two vacuum dryers in the CPP. The dryer chambers will be designed for 450° F and full vacuum, and a production rate of 2200 dry pounds per day. The dryer chambers will be heated externally and fitted with rotating paddles attached to a central shaft to agitate the yellowcake. The chamber will have a top port for loading the dewatered filter cake and a bottom port for unloading the dry powder. A port will be provided for pulling vapors through the baghouse using the vacuum pump.

Baghouse Filter

Each dryer will be connected to a baghouse filter enclosure. Each baghouse filter will have an integrated compressed air blow down system. The baghouse filters will be mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be discharged back to the drying chamber. The bag house filters will be heated to prevent condensation of water vapor during the drying cycle. It will be kept under negative pressure by the vacuum system.

Vacuum Pump and Condenser System

The vacuum pump and condenser systems will include water sealed liquid ring vacuum pumps with seal water reservoirs, seal water cooling heat exchangers, condensers, condensate receivers, and condensate pumps. Three of these systems will be provided, with two being on line and the third acting as a backup unit. The suction side of the vacuum pump will pull vapors from the vacuum dryer through the baghouse and then through the condenser. Seal water will be cooled in a heat exchanger as it flows to the vacuum pump head. Cooling water from the cooling tower will be circulated through the condenser and the seal water heat exchanger. Condensate from the condenser will flow into a receiver tank constructed of 304 SS. When the receiver tank is full as sensed by a level switch, a condensate transfer pump will pump the condensate to the solids removal tank in the wastewater system.

Thermal Fluid Heaters

Packaged electrical thermal fluid heaters will be used to circulate hot thermal fluid through the shell and central shaft of the rotary dryers. Each thermal fluid heater will be equipped with a circulating pump to circulate the thermal fluid through the dryer and back to the heater.

Packaging System

The packaging system will be operated on a batch basis and will include conveyors, scales, and a spray booth. When the yellowcake is dried sufficiently, it will be discharged from the drying chamber through a knife gate valve on the bottom port of the dryer into 55-gallon steel drums. Particulate emissions will be minimized by use a sealed hood that fits on the top of the drum. A weigh scale will be used to determine when a drum is full. A conveyor system will allow drums from both dryers to be moved from beneath the dryer to an enclosed spray booth where each drum will be rinsed with a spray of water. The conveyor system will then move the drum to a scanning station where the drum will be hand scanned for radioactivity and then placed in the storage area or rinsed further.

3.2.7 Restoration

The restoration system is designed to extract, store, and distribute makeup water for restoration of well fields. The restoration system may also incorporate a reverse osmosis (RO) system to remove TDS from extracted water and return low TDS permeate to the restoration system. Reject from the reverse osmosis system, if utilized will be routed to a high TDS wastewater system.

3.2.7.1 Restoration System Equipment

Restoration system equipment includes a restoration water tank, a restoration makeup water pump, and a restoration RO system. Each SF will be equipped for restoration of post-production well fields.

Restoration Water Tank

The restoration water tank will be constructed of FRP. The tank will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room.

Restoration Makeup Water Pump

The restoration makeup water pump will have wetted parts constructed of ductile iron. The pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

Restoration Reverse Osmosis System

The restoration RO system at each site will be a packaged system capable of treating approximately 500 gpm and producing a permeate stream and a reject brine. This system will include necessary pretreatment, including multi-media or sand filters and feed conditioning.

3.2.8 Chemical Storage and Feeding Systems

The ISL process requires chemical storage and feeding systems to store and dose chemicals at various stages in the extraction, processing, and waste treatment processes. Chemical storage and feeding systems will include sulfuric and/or hydrochloric acid, sodium hydroxide, hydrogen peroxide, carbon dioxide, oxygen, sodium chloride, sodium carbonate, barium chloride, and propane. Each chemical storage and feeding system will be designed to safely store and accurately deliver process chemicals to their intended delivery point in the process. Design criteria for chemical storage and feeding systems include applicable sections of the international building code, international fire code, OSHA regulations, RCRA regulations, and Homeland Security

3.2.8.1 Sodium Chloride Storage

Sodium chloride will be used to make up fresh eluant and will be stored in tanks as a saturated solution (approximately 26 percent by weight) in equilibrium with a bed of crystals in each storage tank. Dry sodium chloride will be delivered by truck and will be blown into the storage tanks using air pressure.

Sodium Chloride Tanks

There will be two Sodium Chloride Tanks, each with a capacity of approximately 20,000 gallons. These tanks will be a vertical cylindrical atmospheric tank with a sloped bottom and flat cover. Each tank will be constructed of FRP, and will be approximately 13 ft in diameter with a height of 20 ft. Each tank will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room. Each tank will be connected to a vent header which exhausts through a vent stack on the building roof, and will be equipped with a scrubber to prevent emission of particulates during truck unloading.

Sodium Chloride Pumps

There will be two sodium chloride pumps that will have wetted parts constructed of FRP. Each pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

3.2.8.2 Sodium Carbonate Storage

Sodium carbonate will be used to make up fresh eluant and will be stored in tanks as a saturated solution in equilibrium with a bed of crystals in the storage tank. Sodium carbonate solution must be kept above 140 F to prevent precipitation in the tank and piping. This will be accomplished by heating the water added to the tank, and continuously circulating liquid from the tank through a heat exchanger. An electric heater will be used to heat a thermal fluid to heat the exchanger. Dry sodium carbonate will be delivered by truck and will be blown into the storage tanks using air pressure.

Sodium Carbonate Tank

The sodium carbonate tank will be constructed of FRP, and will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room. The tank will be connected to a vent header which exhausts through a vent stack on the building roof, and will be equipped with a scrubber to prevent emission of particulates during truck unloading.

Sodium Carbonate Pumps

The sodium carbonate pumps will have wetted parts constructed of FRP. Each pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

3.2.8.3 Acid Storage and Feeding System

The acid storage and feeding system will include a storage tank and delivery pump. The storage tank will be located outside of the CPP building in a lined concrete secondary containment basin designed to contain 110 percent of tank volume plus a 25 year, 24 hour storm event. This secondary containment basin will be separate from the containment basins for other chemical systems. The acid feed pump will be located inside the building, directly adjacent to the storage tank.

Acid Storage Tank

The acid storage tank will be designed to store sulfuric or hydrochloric acid. The tank will be constructed of HDPE, and will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room. Each tank will be connected to a vent header which exhausts through a vent stack on the building roof.

Acid Transfer Pump

The acid feed pump will have wetted parts constructed of FRP. The pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

3.2.8.4 Sodium Hydroxide Storage and Feeding System

The sodium hydroxide system will include a storage tank and delivery pump. The storage tank will be located outside of the CPP building in a concrete secondary containment basin designed to contain 110 percent of tank volume plus a 25-year, 24-hour storm event. This secondary containment basin will be separate from the containment basins for other chemical systems. The sodium hydroxide feed pump will be located inside the building, directly adjacent to the storage tank. Sodium hydroxide will be purchased as aqueous caustic soda, and will be pumped directly into the storage tank from the supplier's tanker trucks.

Sodium Hydroxide Storage Tank

The sodium hydroxide storage tank will be constructed of carbon steel. The tank will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room.

Sodium Hydroxide Pump

The sodium hydroxide feed pump will have wetted parts constructed of FRP. The pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

3.2.8.5 Hydrogen Peroxide Storage and Feeding System

The hydrogen peroxide system will include a storage tank and delivery pump. The storage tank will be located outside of the CPP building in a concrete secondary containment basin designed to contain 110 percent of tank volume plus a 25 year, 24 hour storm event. This secondary containment basin will be separate from the containment basins for other chemical systems. The hydrogen peroxide feed pump will be located inside the building, directly adjacent to the storage tank.

Hydrogen Peroxide Storage Tank

The hydrogen peroxide storage tank will be constructed of HDPE, and will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room.

Hydrogen Peroxide Pump

The hydrogen peroxide feed pump will have wetted parts constructed of FRP. The pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

3.2.8.6 Oxygen Storage and Feeding System

Oxygen is typically stored near the CPP or within well field areas, where it is centrally located for addition to the injection stream in each header house. Since oxygen readily supports combustion, fire and explosion are the principal hazards that must be controlled. The oxygen storage facility will be located a safe distance from the CPP and other chemical storage areas for isolation. The storage facility will be designed to meet industry standards in NFPA-503.

3.2.8.7 Carbon Dioxide Storage and Feeding System

The carbon dioxide storage and feeding system will be used to dissolve carbon dioxide into the pregnant lixiviant to improve recovery of uranium in the IX vessel. This system will be a vendor supplied packaged system including cryogenic tank, vaporizer, pressure gauges, and pressure relief devices.

3.2.8.8 Barium Chloride Storage and Feeding System

The barium chloride storage and feeding system includes a storage tank, agitator, and chemical metering pump. This system will be designed to dissolve solid barium chloride in water to make up the solution for feeding into the low TDS wastewater for radium precipitation. This system will be located in a metal building located adjacent to the low TDS wastewater pond.

3.2.8.9 Byproduct Storage

Prior to transportation to a licensed disposal facility, byproduct material will be stored in designated storage buildings (also referred to as "byproduct storage buildings"), one located at the CPP site and one located at the SF site. These buildings will consist of a concrete slab with a containment curb surrounding the perimeter. Storage of byproduct material will be within "roll-off" containers (bins) which are both liquid tight and fully enclosed. As each storage building can accommodate two 20 cubic yard bins, the volume of byproduct material could accumulate to 30 to 40 cubic yards at each of the two storage locations prior to transport. There are two bays in each storage building, each accessed by an overhead roll-up door and allowing exchange of containers necessary for transport to a licensed 11e.(2) disposal site. The concrete slabs will be designed to allow external decontamination of the roll-off bins prior to transport.

The byproduct storage buildings will allow for control of byproduct materials and specific segregation of these wastes from other non-11e.(2) wastes. Typically these wastes are expected to consist of contaminated used equipment parts, personal protective equipment, and wastes from cleanup of spills or other housekeeping activities. Other waste not in contact with the uranium production process will be disposed of in regular dumpsters situated at a separate location.

Containment of these byproduct wastes within a designated, fully enclosed building will allow for proper control of the materials, monitoring, and necessary restricted access. These measures will ensure best possible control of 11e.(2)solid and liquid wastes to minimize any potential exposures or contamination.

3.2.9 Utility Water

The utility water system will be used to extract, store, and distribute water for consumptive process uses and potable uses. Water will be extracted from wells drilled in a suitable formation in the vicinity of the SF and CPP. Water for potable uses will be chlorinated and stored in a pressurized tank.

3.2.9.1 Utility Water System Equipment

The utility water system equipment will include the utility water tank and utility water pumps.

Utility Water Tank

The utility water tank will be constructed of FRP, and will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room.

Utility Water Pump

The utility water pump will have wetted parts constructed of FRP. Each pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

3.2.10 Wastewater

The wastewater system will be designed to receive, treat, and discharge wastewater generated at various stages of the process. The wastewater system will be divided into two main categories of wastewater, high TDS wastewater, and low TDS wastewater. High TDS wastewater consists of waste eluant brine from the CPP and the reject streams from process bleed or restoration reverse osmosis systems if these systems are in use. Low TDS water sources include process bleed and extracted restoration water that have not been concentrated by a reverse osmosis process.

High TDS wastewater will flow by gravity from the solids removal tank to the high TDS wastewater tank. This wastewater will then be pumped to an onsite deep disposal well, into a tanker truck for off site disposal, or to the high TDS wastewater holding pond.

Low TDS wastewater will be collected in the low TDS wastewater tank and then pumped to a radium precipitation tank where barium chloride will be added to co-precipitate barium and radium sulfates. Treated wastewater will flow from the radium precipitation tank to the low TDS wastewater pond for removal of the precipitate by settling.

3.2.10.1 Wastewater System Equipment

Wastewater system equipment includes the solids removal tank, the high TDS wastewater tank, the low TDS wastewater tank, the wastewater pumps, the radium precipitation tank and agitator.

Solids Removal Tank

The Solids Removal Tank will be constructed of FRP, and will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room. Each tank will be connected to a vent header which exhausts through a vent stack on the building roof.

High TDS Wastewater Tank

The High TDS Wastewater Tank will be constructed of FRP, and will be equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room. Each tank will be connected to a vent header which exhausts through a vent stack on the building roof.

Low TDS Wastewater Tank

The Low TDS Wastewater Tank will be constructed of FRP, and will equipped with a level indicator/transmitter which will measure and indicate tank level both locally and in the control room.

Wastewater Pumps

Wastewater pumps will be provided for both high TDS wastewater and for low TDS wastewater, as needed, depending on the processing option selected in the final design. Each pump will have wetted parts constructed of FRP. Each pump will be equipped with a pressure indicator on the pump discharge line, and a flow meter and flow indicator transmitter in the discharge line. Flow will be indicated both locally and in the control room. The measured flow will be used to control pump motor speed via a variable frequency drive.

Radium Precipitation Tank

The radium precipitation tank will be used to add barium chloride to the wastewater and provide thorough mixing prior to discharge to the wastewater pond.

3.2.11 HVAC System

The heating, ventilating and air conditioning (HVAC) systems in the SF and CPP will be designed to provide routine heating, cooling and required air changes in occupied areas, as well as mitigate the potential for human exposure to radionuclides. The primary exposure concerns will be radon gas and uranium oxide dust or particulates.

The HVAC system for the main plant area will be designed both for controlling the temperature in the main plant area, and for preventing the buildup of fugitive radon emissions by ensuring a minimum number of air changes.

Radon gas is a daughter product of radium, which is present in the orebody, and thus is mobilized and dissolved into the pregnant lixiviant during production. The potential for radon emissions from the process arises when the pressurized flow from the extraction wells and booster pumps is exposed to atmospheric pressure. The two process systems with the potential for radon emissions are the IX vessels via the air/vacuum relief valves, and the shaker screens where the loaded resin and resin transfer water will be pumped onto an open screen at atmospheric pressure.

The shaker screens will each have a dedicated vent hood directly overhead. The vent hoods will be connected to an exhaust fan designed to create sufficient air flow and velocity to minimize the emission of radon in the vicinity of the shaker screens. The exhaust fans will discharge the air through a vent stack in the roof of the building. The vent stack will be located away from air intakes for the building.

Systems that have the potential to emit dust particles containing uranium include the filter presses, the dryers, and the drum filling stations.

The filter presses will be installed in a dedicated filtration room, and the vacuum dryers will be installed in a dedicated dryer room. These two rooms will be serviced with dedicated HVAC equipment that includes particulate filtration to minimize the potential for personnel exposure within the rooms and to prevent the emission of particles.

3.2.12 Instrumentation and Control

The control system for both the SF and CPP will include a programmable logic controller (PLC), personal computer (PC) based operator interface stations, and remote digital and analog input/output (I/O) racks. Instruments and devices that send or receive digital or analog signals to/from the control system will be wired to the remote I/O racks. The remote I/O racks will be connected to the PLC via Ethernet cables. The control systems at the SFs and the CPP will receive critical process variable signals such as header pressure and flowrate from header houses via radio frequency signal.

The control system will enable operators to use the operator interface in the control room to configure flowpaths for process streams by opening and closing valves. Operators will also be able to use the operator interface to start and stop pumps and other equipment, monitor and control liquid levels, flowrates, pressures, and temperatures in process equipment. The control system will also allow operators to monitor process variables and trouble alarms from packaged equipment systems in the control room. Control interlocks will be provided to prevent overfilling of tanks during liquid transfers within the CPP and from tanker trucks filling storage tanks. Control interlocks will also be configured to prevent overpressure conditions in equipment and piping both inside the SF or CPP, as well as in the header houses and pipelines.

3.3 OSHA Design Criteria

In addition to the design criteria discussed in the preceding subsections worker health and safety measures identified in 29 CFR Part 1910 will be incorporated into design of the ISL production and processing facilities, as discussed below.

- Walking and working surfaces (Subpart D) - Aisles, passageways, and storage areas will be designed to be free of obstruction such that emergency egress will not be hindered. Wet areas in the plant will be provided with drainage, platforms, mats, or other dry walking surfaces, as necessary. All open-sided platforms or other working areas greater than 4 feet high will be equipped with standard railings. Flights of stairs more than 4 risers high will be equipped with standard hand railings in accordance with OSHA requirements.

- Means of egress (Subpart E) – Building will be designed and maintained to facilitate emergency egress. Exits will be clearly marked with illuminated exit signs.

- Occupational Health and Environmental Control (Subpart G) – Facilities will be designed with adequate ventilation systems to control worker exposure to vapors and temperature extremes. Noise will be minimized using engineering and administrative controls to ensure worker noise exposures are maintained below the permissible limits. As necessary, air compressors will be isolated to minimize noise levels within the processing facilities.

- Hazardous Materials (Subpart H) –Acid, caustic, and hydrogen peroxide storage areas will be individually curbed to provide secondary containment for each chemical. Sodium chloride, sodium carbonate, and barium chloride storage tanks will also have secondary containment, but do not need to be individually segregated. Operators will be provided hazard communication training, will have an MSDS onsite for these chemicals, and will have appropriate personal protective equipment (PPE) available for tank system maintenance and spill cleanup. An emergency eyewash/shower will be located adjacent to the storage areas. Spill response procedures will be included in the plant operating procedures. If used, flammable materials will be stored in the flammable storage locker.

- Personal Protective Equipment (PPE) (Subpart I) - The standards associated with respiratory, electrical, head, foot, and eye protection will apply. A workplace hazard assessment will be performed and documented. PPE is not expected to be required because of the engineering and administrative controls that will be used to mitigate identified hazards. PPE will be used only to supplement these controls when required to ensure protection of employees.

- General Environmental Controls (Subpart J) - The general sanitation requirements for fixed facilities are applicable to the treatment facility. A restroom with a toilet and sink serviced by potable water will be provided. Fire systems and physical hazards will be color coded in accordance with subpart requirements. In addition to OSHA requirements, piping and facilities systems will be labeled.

- Medical and First Aid (Subpart K) - Plant operators will be trained in first aid and cardiopulmonary resuscitation. A first aid kit, eyewash, and emergency shower will be available.

- Fire Protection (Subpart L) – Portable fire extinguishers will be placed within the plant such that the maximum travel distance to an extinguisher will be less than 50 feet. Portable extinguishers will be inspected monthly and subjected to an annual maintenance check. In addition, the CPP, office building, maintenance area, and warehouse will be equipped with automatic fire sprinklers.

- Compressed Gas Equipment (Subpart M) - Compressed air piping, safety valves, and pressure gages will be constructed to American Society of Mechanical Engineers (ASME) standards. Safety valves will be inspected frequently and at regular intervals to determine operational condition.

- Materials Handling and Storage (Subpart N) - Safe clearances, secure storage, good housekeeping, and guarding of fall hazards will be used to protect workers. Forklift operators will be trained in accordance with 29 CFR 1910.178.

- Machinery and Machine Guarding (Subpart O) – Workers will be protected from physical hazards associated with grinding, fans, rotating shafts, and pinch points through guarding in conformance with subpart requirements.

- Electrical Installations (Subpart S) - All electrical installations will be made in conformance with the National Electric Code and will be designed and installed by competent persons. Ground-fault circuit interrupters will be used for power tools or for other circuits that are not part of the plant's permanent wiring. Operators will be trained in electrical safety.

- Toxic and Hazardous Substances (Subpart Z) - Potential chemical hazards at the plant include acids, caustics, oxidants, brine solutions, barium chloride, ammonium sulfate, uranium, radium, and radon gas. Fire notification to employees will be through voice communication. Fire Department response will be initiated through the 911 emergency telephone system. Workers will be provided hazard communication training and exposure monitoring will be conducted as necessary to ensure compliance with subpart requirements.

3.4 References for Uranium Processing

The uranium processing techniques proposed for this project are well documented in the literature and have been successfully implemented in the United States for the past 20 years.

3.5 Master Schedule

The proposed Dewey-Burdock ISL mine schedule is shown on Figure 1.9-1. The mine schedule is preliminary based on Powertech's (USA) current knowledge of the recoverable reserves, land ownership, available water rights, and uranium market conditions. As the project is developed, the mine schedule will be updated accordingly.

3.6 References

Center for Nuclear Waste Regulatory Analyses, NUREG/CR-6733, "*A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses*", 2001.

Compressed Gas Association, CGA G-4.1, "*Cleaning Equipment for Oxygen Service*", (CGA, 2000).

Compressed Gas Association, CGA G-4.4, "*Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems*", (CGA, 1993).

Hunkin, G. G., 1977, "*Uranium In-Situ Leaching in the Tertiary Deposits of South Texas, Chapter 3: Resource Development / Utilization in Geology of Alternate Energy Resources in the South-Central United States*" (M. D. Campbell (ed), Houston Geological Society, pp. 67-82. See: http://www.ela-iet.com/ie08000B.htm

National Fire Protection Association, NFPA-50, "*Standard for Bulk Oxygen Systems at Consumer Sites*", (NFPA, 1996).

Sterrett, R. J., "*Groundwater and Wells*", Third Edition, (Johnson Division, 2008).

U.S. Nuclear Regulatory Commission, June 2003, "*NUREG-1569 – Standard Review Plan for In Situ Leach Uranium Extraction License Applications – Final Report*", USNRC, Office of Nuclear Material Safety and Safeguards, Washington, D.C.

US Nuclear Regulatory Commission, NUREG-1910, "*Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities*", US Nuclear Regulatory Commission, July, 2008.

4.0 Effluent Control Systems

4.1 Gaseous and Airborne Particulates

Powertech (USA) Inc. will conduct an airborne radiation monitoring program at the Dewey-Burdock facility which is consistent with the recommendations contained in RG 8.30 and will consist of monitoring radon decay products as well as airborne particulate monitoring. Powertech (USA) Inc. will also conduct an airborne effluent and environmental monitoring program during construction and operations consistent with recommendations in USNRC Regulatory Guide 4.14 "*Radiological Effluent and Environmental Monitoring at Uranium Mills*" (RG 4.14).

This section describes the expected radionuclide airborne emissions from the Dewey-Burdock uranium recovery facilities. Airborne emissions are categorized in two subsections, radon and radionuclide particulates. Potential sources of emissions and a basic description of monitoring for worker protection are described based on the design of the Dewey-Burdock ISL process as well as the emission controls systems that will be employed to maintain radionuclide effluents well below regulatory limits and as low as is reasonably achievable.

4.1.1 Radon

According to RG 8.30, measurements of radon decay products are a better measure for worker dose than measurements of radon. Therefore, measurements of radon decay products will be made in the facility. Working level (WL) measurements for radon decay products will be made on a monthly basis in areas where radon decay product concentrations are likely to exceed 0.03 WL as described in RG 8.30. The time, date, and state of operation of the equipment in the vicinity of the measurement will be recorded. Refer to section 5.0 Operations for a detailed description of the radon and radon decay products monitoring program and the proposed locations of monitoring stations.

The primary radioactive airborne effluent at the Dewey-Burdock ISL Facility will be radon-222 gas. Radon-222 is dissolved in the pregnant lixiviant that comes from the well field into the facility for separation of uranium. At the locations where the lixiviant solution is initially exposed to atmospheric pressure and ambient temperatures, radon gas will be evolved. These locations constitute primary release points and are expected to include the IX vessels into which the lixiviant is directed for loading of the uranium onto resin and the elevated shaker screens, which will receive the loaded resin prior to elution (NMA 2007, Brown 1982, 2007, 2008). The

IX vessels will normally operate as sealed, pressurized vessels, so that radon releases from the IX vessels will only occur during resin transfer operations. Dedicated local exhaust at the IX vessels and shaker screens will be directed to a manifold that is exhausted to the atmosphere outside the building via an induced draft fan. Exhausting radon-222 gas to the atmosphere outside the plant minimizes opportunity for in-growth of radon particulate daughter products (progeny) in occupied work areas and therefore minimizes employee airborne exposure. Small amounts of radon-222 may also be released from the well field, solution spills, filter changes, 11e (2) by-product impoundment areas, reverse osmosis (RO) system operation during groundwater restoration, and maintenance activities. These secondary and/or infrequent additional releases would be quite small relative to radon dissolved in the pregnant lixiviant returning from underground. Radon releases associated with these secondary release points have been shown to be minor components of the overall facility radon-222 source term. (NMA 2007, Marple and Dziuk 1982, Brown 1980, 2007, 2008). An operational monitoring program will be utilized that is similar to the preoperational monitoring program set up to measure radionuclide particulates and radon -222 that may result in the atmosphere outside the building and other specified locations within the PAA.

The filters from air samplers operating continuously will be analyzed quarterly for natural uranium, thorium-230, radium-226, and lead-210. Samplers will have sensors to measure total air flow within a sampling period. Passive track-etch detectors will be deployed at each station for monitoring radon-222 on a quarterly basis. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14. Additionally, effluents from the yellowcake dryer and packaging stacks will be sampled quarterly. The grab samples will be isokinetic in nature and will be analyzed for natural uranium, thorium-230, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with recommendations of RG 4.14. Refer to section 5.0 Operations for a detailed description of the particulate air monitoring program and the proposed locations of monitoring stations.

The general HVAC system in the plant will further reduce employee exposure by removing radon from plant air and will be exhausted through a separate stack. This system will be connected via ductwork and manifolds to the eluant and precipitation tanks. Potential release points as well as general air in the plant will be routinely sampled for radon daughters to assure that concentration levels of radon and progeny are maintained as low as reasonably achievable (ALARA). Sampling and monitoring methods specific for radon progeny will be used (USNRC 2002a). Results of monitoring obtained during initial plant operation will be used to adjust monitoring programs (location, frequency, etc), upgrade ventilation and/or other effluent control equipment as may be necessary.

Redundant exhaust fans will direct collected gases to discharge piping that will exhaust fumes to the outside atmosphere. Redundancy of fans will minimize employee exposures should any single fan fail. Discharge points will be located away from building ventilation intakes to prevent introducing exhausted radon back into the facility (NRC 2002b). Airflow through any openings in the vessels will be from the process area into the vessel and then into the ventilation systems, maintaining negative flow into the vessel and controlling any releases. (note that the lixiviant circuit through IX will be a closed system; atmospheric conditions will initially be encountered during resin transfer at the shaker screens.) Tank ventilation of this type has been successfully utilized at other ISL facilities and proven to be an effective method for minimizing employee exposure. (Brown 1982, 2007, 2008)

The general building ventilation system will be designed to maintain air flow from the least likely to most likely process areas with potential for airborne releases and then exhaust to outside areas. Ventilation systems will exhaust outside the building and draw in fresh air. During favorable weather conditions, open doorways and convection vents in the roof will provide supplemental work area ventilation.

4.1.2 Radionuclide Particulates

Since there will be no ore grinding at the facility, no monitoring of airborne uranium ore dust will be necessary. However, airborne yellowcake will be monitored at the facility. The facility will be drying yellowcake under low temperature (less than 400 °C). According to the footnotes of 10 CFR 20 Appendix B, yellowcake dried under low temperature should be considered soluble. Weekly 30 minute grab samples (low volume breathing zone samples) will be taken in airborne radioactivity areas. Breathing zone samples provide a better estimate of airborne particulate concentrations to which workers are exposed, resulting in a more representative estimate of actual intakes. The sensitivity of this method shall be at least 1×10^{-11} μCi / mL. Breathing zone samples will be taken during non-routine operations with potential for a worker to receive exposure to airborne yellowcake above 1×10^{-10} μCi / mL. Refer to section 5.0 Operations for a detailed description of the radon and radon decay products monitoring program and the proposed locations of monitoring stations.

Potential radiological air particulate effluents are generated primarily from dried uranium concentrate in the yellowcake drying and processing areas. Following precipitation, the uranium concentrate is fed to a gravity thickener. The gravity-thickened yellowcake solids solution will be pumped into a plate and frame filter press for dewatering from which the product is only at an approximately 60 percent solids content. Dewatered yellowcake drops from the filter press into a live bottom hopper with a screw auger to move the pressed yellowcake slurry to a sump where a progressing-cavity positive displacement pump transfers the yellowcake to the dryers. Although minor spills can occur during the thickening and dewatering process, they would be cleaned up quickly and subsequently surveyed to minimize any potential airborne source.

4.1.2.1 Yellowcake Drying and Packaging

The yellowcake drying and packaging area at the Dewey-Burdock ISL facility will be serviced by a dedicated ventilation system. By design, vacuum dryers do not discharge uranium for the following reasons. The vacuum drying system is proven technology, which is being used successfully at several facilities where uranium oxide is being produced, including ISL facilities (NMA 2007). The off gas treatment system of the vacuum dryers includes a baghouse, condenser, vacuum pump, and packaging hood. The potential radionuclide particulate releases from the drying process and associated off gas treatment system are discussed below.

The yellowcake will be dried at approximately 250 degrees Fahrenheit (°F) in the rotary vacuum drying process. The off gases generated during the drying cycle are filtered through a baghouse, which is located on the top of the dryer, to remove particles down to approximately 1 micron in size. The gases are then cooled and scrubbed in a surface condenser to further remove the smaller size fraction particulates and the water vapor during the drying process. Two rotary vacuum dryers will be located in a separate building attached to the CPP. This attached building will contain the dryers, the baghouses on the dryers, and a condenser scrubber and vacuum pump system for each dryer. The dryers will be heated with a heat transfer fluid (HTF) that circulates through the shell and the rotating central shaft. The heat transfer fluid will be heated by two natural gas or propane-fired HTF heaters, each provided with HTF pumps for circulating the HTF through the shell and central shaft of the dryer. The HTF heaters and pumps will be in a separate structure attached to the back of the dryer building. The water-sealed vacuum pumps will provide the vacuum source while the dryer is being loaded and while the yellowcake is unloaded into drums.

The vacuum dryers are steel vessels heated externally as described above and fitted with rotating plows to stir the yellowcake. The chamber will have a top port for loading the wet yellowcake and a bottom port for unloading the dry powder. A third port will be provided for venting through the baghouse during the drying procedure. The baghouse and vapor filtration unit will be mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The baghouse will be heated to prevent condensation of water vapor during the drying cycle. It will be kept under negative pressure by the vacuum system.

The condenser will be located downstream of the baghouse and will be water cooled. It will be used to remove the water vapor from the non-condensable gases emanating from the drying chamber. The gases are moved through the condenser by the vacuum system. Dust passing through the bag filters is wetted and entrained in the condensing moisture within this unit. The vacuum pump will be rotary water sealed providing negative pressure on the entire system during the drying cycle. It will also be used to provide negative pressure during transfer of the dry powder from the drying chamber to 55-gallon steel drums. The water seal of the rotary vacuum pump captures entrained particulate matter remaining in the gas streams.

The packaging system will be operated on a batch basis. When the yellowcake is dried sufficiently, it will be discharged from the drying chamber through a bottom port into 55-gallon steel drums. A level gauge, a weigh scale, or other suitable device will be used to determine when a drum is full. Particulate capture will be provided by a sealed hood that fits on the top of the drum, which will be vented through a sock filter to the condenser and the vacuum pump system when the powder is being transferred.

4.1.2.2 Atmospheric Discharges from the Yellowcake Drying and Packaging System

Only the vacuum pump discharges to the atmosphere. The vacuum pump is a rotary water sealed unit that provides a negative pressure on the entire system during the drying cycle. It is also used to provide ventilation during transfer of the dry powder from the drying chamber to 55-gallon drums. The water seal of the rotary vacuum pump captures entrained particulate matter remaining in the gas streams and is recycled back to the process. This point of discharge will be routinely monitored via filter collection and radiochemical analysis for Natural U, Th 230, Ra 226 and Pb 210 to ensure radionuclide effluent releases are maintained ALARA. The water that is collected from the condenser will be recycled to the precipitation circuit, eluant makeup, or disposed with other process water. General plant air will be monitored routinely for airborne radionuclides.

The system will be instrumented sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures. The system will alarm if there is an indication that the emission control system is not performing within operating specifications. If the system is alarmed due to the emission control system, the operator will follow standard operating procedures to recover from the alarm condition, and the dryer will not be unloaded or reloaded until the emission control system is returned to normal service.

To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signal an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is routinely monitored during dryer operations. The operator will perform and document inspections of the differential pressure or vacuum every four (4) hours. Additionally, the air pressure differential gauges for other emission control equipment is observed and documented at least once per shift during dryer operations.

4.1.3 Other Airborne Emissions

Other emissions to the air are possible from limited vehicular traffic (exhaust and dust). Potential impacts from potential emissions from process chemicals that will be used at the plant are described in Section 7.5. There will not be any significant combustion related emissions from the process facility as commercial electrical power is available to the site.

4.2 Liquid Waste

4.2.1 Sources of Liquid Waste

Several sources of liquid waste are collected as a result of ISL production:

- Storm water runoff
- Waste petroleum products and chemicals
- Domestic sewage and
- Three types of byproduct materials

According to the latest interpretation concerning 11e.(2) defined in Chapter 2, Section 11 of the AEA of 1954, more fluid type wastes are associated in order to provide regulation within the ISL industry (NUREG-1575, 2000). Three types of liquid waste fall within the confines of the 11e.(2) definition:

- Liquid process wastes, including laboratory chemicals
- Groundwater generated during aquifer restoration.
- Affected groundwater generated during well development; and

The following sections presents potential liquid waste sources and effluent controls to be utilized during process operations at the Dewey-Burdock project.

4.2.1.1 Liquid Process Waste

The primary source of liquid waste, as previously discussed in Section 3.0, is the operation of the IX process which generates production bleed. This bleed will either be sent to a deep disposal well or will be treated with barium chloride and then used to irrigate alfalfa within the Permit Area using center-pivot sprinklers. Other sources of liquid waste from the CPP include laboratory chemicals, laundry water, plant wash down water and the waste brine streams from the elution and precipitation circuits; however, these liquid waste streams make up a much smaller portion of the total liquid waste stream at the Dewey-Burdock facility. These wastes will be collected, treated, and discharged to the deep disposal well.

4.2.1.2 Aquifer Restoration

The groundwater restoration method proposed for the Dewey-Burdock Project is based on the successful programs implemented by other projects such as the Lamprecht, Cogema Irigaray Restoration Project or Crow Butte Resources, Inc., which have received regulatory approval from NRC for successfully restoring groundwater to previous class of use. The groundwater restoration methods consist of permeate injection using the reverse osmosis process and aquifer recirculation. Refer to Section 6 of the Technical Report for detailed description of restoration techniques.

4.2.1.3 Water Collected from Well Field Development

During well development or redevelopment, water will be collected, treated and the waste will be disposed of via a deep disposal well or treatment and land application. Water from injection lixiviant or recovery fluids recovered from areas where a liquid release has occurred from a pipeline or well will be placed into the wastewater disposal system for either deep well disposal or treatment and land application.

4.2.1.4 Storm water Runoff

Another source of liquid waste is stormwater runoff. DENR is responsible for administering the stormwater management program that is closely modeled after the federal National Pollution Discharge Elimination System (NPDES) program. Facility drainage will be designed to route stormwater runoff either away from or around the plant, ancillary buildings and parking areas, and chemical storage. The design of the project facilities, combined with engineering and procedural controls contained in a Best Management Practices (BMP) Plan, will ensure that stormwater runoff is not a potential source of pollution.

4.2.2 Liquid Waste Disposal

4.2.2.1 Land Application

As noted in this TR, Powertech (USA) is considering two approaches to disposal of liquid wastes arising from well field operations at the Dewey-Burdock ISL operations: 1) These approaches are deep well disposal and 2) land application. This section addresses the disposition of water using land application. Bleed water from the process lixiviant circuit will be extracted following uranium removal in the IX columns. Bleed water will then flow through secondary ion-exchange columns to further remove uranium and other metals. This water will be discharged to lined settling ponds, where radium will be precipitated using barium sulfate. Water from these ponds will then be pumped to center pivot sprinklers and used to irrigate alfalfa during the growing season (May 11 to September 24) and due to the evapotranspiration data obtained during baseline characterization it is not out of the question for irrigation to occur throughout the year. Water from the ponds will be sampled before it is pumped to the sprinklers to ensure that it meets the applicable discharge standards for all constituents.

It is anticipated that several potential crops such as alfalfa, corn, sorghum and several species of salt tolerant wheatgrass would be irrigated. During the irrigation season, water application rates are determined during operation to optimize both evaporation and crop production.

The design of the land application system was developed based on modeling using the SPAW model, which is described in the following sections. Two land application areas, one at the Dewey site and one at the Burdock site will be used. The land application areas and the settling ponds for the Dewey and Burdock sites are shown on Figure 2.1-1. The total irrigated area at any given time at the Dewey site would be 375 acres, consisting of six 50-acre pivots plus three 25-acre pivots. In addition, there would be one 50-acre pivot and one 25-acre pivot on standby (total pivots at Dewey is seven 50-acre pivots and four 25-acre pivots). Pumping at Dewey would occur for 24 hours every day during the growing season (May 11 to Sept 24). Pumping rates at Dewey would be 113 gpm on each 50-acre pivot and 57 gpm on each 25-acre pivot. This equals a total of 849 gpm pumped for 24 hours on every day of the growing season at Dewey.

The total irrigated area at any given time at the Burdock site would be 500 acres (eight 50-acre pivots plus four 25-acre pivots). In addition, there would be four 25-acre pivots on standby (or any combination of pivots equal to 100 acres capacity). The total pivots at Burdock would be eight 50-acre pivots and eight 25-acre pivots. Pumping at Burdock would also occur for 24 hours on every day of the growing season (May 11 to Sept 24). Pumping rates at Burdock would be 85 gpm on each 50-acre pivot and 42.5 gpm on each 25-acre pivot. This equals a total of 849 gpm pumped for 24 hours on every day of the growing season.

Four lined impoundments (ponds) with leak detection will be constructed at the Dewey site for settling of radium and temporary storage of the irrigation water. Each pond will be 560 feet x 560 x 33 feet deep including 3 feet of freeboard, with a total capacity of 157 acre-feet.

Six lined ponds with leak detection will be constructed at the Burdock site for settling of radium and temporary storage of the irrigation water. Each pond will be 560 feet x 560 feet x 33 feet deep including 3 feet of freeboard, with a total capacity of 157 acre-feet. Five of the ponds will be operational at any given time and one will be a backup pond. In addition there will be a CPP pond at the Burdock site for storing process water prior to treatment. The CPP pond will be 380 feet x 380 feet x 33 feet including 3 feet of freeboard, with a total capacity of 63 acre-feet.

4.2.2.1.1 SPAW Model Description

The SPAW (Soil-Plant-Atmosphere-Water) Model was developed by the U.S. Department of Agriculture (Saxton and Willey, 2006) to simulate the daily hydrologic water budgets of agricultural landscapes by two connected routines, one for farm fields and one for impoundments such as irrigation ponds. The field hydrology simulation is represented by: 1) daily climatic descriptions of precipitation, temperature, and evaporation, 2) a soil profile of interacting layers each with unique water holding characteristics, and 3) annual crop growth with management options for rotations, irrigation, and fertilization. The model output for the field hydrology routine includes a daily vertical, one-dimensional water budget depth for all major hydrologic processes such as runoff, infiltration, evapotranspiration, soil water profiles, and percolation. Water volumes for each component of the water balance are estimated by multiplying the water budget depth times the associated field area.

Pond hydrology simulations provide water budgets by multiple input and depletion processes for impoundments whose water source is runoff from agricultural fields and/or water produced by wells or other sources. Model outputs for the pond hydrology routine include daily values of depth, volume, precipitation, evaporation, and change in storage for the period of simulation. The version of the SPAW model used was Version 6.02.75. The model has been extensively tested by the developers using research data and real-world applications.

4.2.2.1.2 Model Input Parameters

4.2.2.1.2.1 Meteorological Parameters

The local climate at the project site is continental, with hot summers, cold winters, and an average annual precipitation of 16.4 inches. The wettest months are from April to September. May and June are the months of highest average precipitation, with occasional thunderstorms that can be severe. Typical daytime temperatures range from 35 degrees Fahrenheit (°F) in January to 85 °F in July, with nighttime temperatures dropping by approximately 15 to 30 °F.

Because of limited on-site climatic data, twenty-eight years of daily precipitation and temperature values (from 1980 to 2007) from the nearest available meteorological station at Edgemont, South Dakota were downloaded from the National Climatic Data Center and used as input data for the SPAW Model. The Edgemont station is approximately 13 miles southeast of the site at an elevation of 3460 feet above mean sea level (amsl). The project plant site is at 3720 feet amsl. Table 4.2-1 shows the average monthly air temperature data at the Edgemont station for the 28-year period of record.

Table 4.2-1: Average Monthly and Annual Air Temperature at Edgemont, SD Station (°F)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
22.6	26.8	36.6	46.7	56.9	66.4	74.3	72.5	61.3	47.8	33.0	22.6	47.3

4.2.2.1.2.1.1 Precipitation

Daily precipitation values for the 28-year period of record from the Edgemont station were used as input data for the SPAW Model. Where daily data were absent in the record, the daily average for that month from the 28-yr record was used. No adjustments were made to the precipitation values for the 260-foot elevation difference between the Edgemont station and the project site. Table 4.2-2 shows the average monthly precipitation at the Edgemont station for the 28-yr period of record.

Table 4.2-2: Average Monthly and Annual Precipitation at Edgemont, SD Station (inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0.33	0.50	1.09	1.87	2.48	2.60	2.17	1.59	1.38	1.31	0.69	0.43	16.44

4.2.2.1.2.1.2 Potential Evapotranspiration

The SPAW model requires daily potential evapotranspiration (PET) data. Lake evaporation is a close estimate of PET, and is similar to PET values estimated using the Penman method. The mean annual lake evaporation (PET equivalent) at the site was determined to be 44 inches using the Evaporation Atlas for the Contiguous 48 United States (Farnsworth and Thompson, 1982). The monthly PET was calculated by applying the values for the monthly distribution of evaporation for the north central United States that are contained in the SPAW model. The daily PET for each month was then calculated by dividing the monthly PET by the number of days in the month. Table 4.2-3 shows the estimated average monthly and annual potential evapotranspiration at the site that was calculated using this method.

Table 4.2-3: Average Monthly and Annual Potential Evapotranspiration at Project Site (inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0.92	1.23	1.98	3.30	4.40	5.76	7.08	6.95	5.50	3.74	2.02	1.10	44.0

4.2.2.1.2.2 Material Properties

To characterize the soils at the site, eleven test pits were excavated on July 11 and 12, 2008. Samples were collected at various depths and analyzed for particle size distribution, dry bulk density, permeability, and other geotechnical parameters. Test pits 1 through 5 were excavated at the Dewey land application area, and test pits 6 through 11 were excavated at the Burdock land application area. The test pit locations are shown on Plate 2.5-1. Table 4.2-4 shows the USDA soil texture and dry bulk density for the test pit samples. These are the parameters that are used as input to the SPAW model.

Natural Resources Conservation Service (NRCS) soil survey maps for the PAA were downloaded from the NRCS Web Soil Survey. The particle size distributions for the NRCS soil mapping units were compared to the laboratory particle size distributions for the test pit soil samples. This comparison showed that the laboratory results for the test pit samples generally fell within the range of particle size distributions for the NRCS survey soil mapping units.

Table 4.2-4: Summary of Test Pit Soil Properties USDA Soil Texture Class and Dry Bulk Densities

Sample No.	Depth	Gravel	Sand	Silt	Clay	Dry Bulk Density
Units:	(ft)	% by wt	% by wt	% by wt	% by wt	(lb/ft^3)
TP01-1	1	0.20	26.20	38.00	35.60	N/A
TP01-3	3	0.10	25.70	27.20	47.00	101.20
TP01-7	7	0.90	8.10	57.20	33.80	86.30
TP02-1	1	0.00	19.90	40.70	39.40	94.50
TP02-4	4	0.00	16.70	34.60	48.70	101.50
TP02-7	7	0.20	26.70	34.80	38.30	92.50
TP03-1	1	0.00	24.30	24.80	50.90	90.00
TP03-7	7	0.00	2.40	25.10	72.50	104.60
TP03-11	11	60.00	25.00	8.90	6.10	
TP04-1	1	2.20	47.80	18.20	31.80	98.10
TP04-7	7	1.30	27.50	28.00	43.20	113.30
TP05-1	1	1.50	24.00	31.60	42.90	97.00
TP05-4	4	2.00	30.00	23.40	44.60	94.80
TP05-8	8	0.80	22.10	57.60	19.50	106.30
TP06-1	1	0.30	17.90	30.80	51.00	N/A
TP06-7	7	0.00	42.00	31.80	26.20	N/A
TP06-10	10	0.00	40.00	31.20	28.80	N/A
TP07-1	1	0.60	17.40	27.30	54.70	105.30
TP07-5	5	0.1	22.1	25.9	51.9	103.90
TP07-10	10	0.3	19.7	6.9	73.1	105.40
TP08-2	2	0.1	11.9	35.7	52.3	95.20
TP08-6	6	0.4	56.6	25.4	17.6	103.40
TP09-1	1	0.3	15.2	39	45.5	94.90
TP09-4	4	0.1	35.9	37.8	26.2	109.60
TP10-1	1	1.8	21.1	34.8	42.3	99.10
TP10-7	7	0.4	11.1	30.3	58.2	105.80

Notes: N/A = Results for these samples were not available.

In addition to soil data from test pits, soil samples were obtained from 37 auger holes of which 18 were at the Dewey site and 19 were at the Burdock site located as shown on Plate 2.5-1. Soil samples were collected by BKS at various depths and analyzed for selected physical/chemical characteristics including saturated paste extracts for electrical conductivity (EC), pH, Ca, Mg, Na, Cl, SO_4, HCO_3, As, Ba, Cd, Cr, Pb, Hg, Se, and Ag. USDA percent sand, silt and clay, as well as organic matter, natural moisture content, and saturation moisture content also were determined. Table 4.2-5 summarizes average values at each site for EC, pH, organic matter, Ca, Mg, Na, sodium adsorption ratio (SAR), exchangeable sodium percentage (ESP), residual sodium carbonate (RSC), USDA soil texture, and as concentrations for the upper soil layer (0 to 11 inches below ground surface) and the deeper soil layer (approximately 50 inches below ground surface) for the auger samples. These are the parameters that are used to assess the success of growing alfalfa using the treated process water.

Analysis of Table 4.2-5 indicates that the existing soils to be irrigated at both the Dewey and Burdock sites indicates that the existing soils are fine grained; comprised of primarily clay, clay loam, and silty clay textures. Particularly at Dewey, the sodicity of the soils, as reflected by SAR, could be a source of concern if these soils are irrigated. At both the Dewey and Burdock sites the physical/chemical constituents increase with soil depth and are typically high values below the top one-foot of soil, as would be expected in these fine-grained soils of marine sediment parent material.

The two potential issues associated with long-term application of treated process water to the Dewey and Burdock sites are changes in the physical properties of the soils (lower hydraulic conductivity and crusting) and changes to the chemical properties of the soils (increased salts and trace metals). These potential changes will be closely monitored.

Table 4.2-5: Summary of Dewey and Burdock Soil Physical/Chemical Characteristics in Land Application Areas[7]

Area	Depth	EC	pH	Organic Matter	Ca	Mg	Na	SAR	ESP[6]	USDA	As
	(in)	(mS/cm)	(std. units)	(%)	(meq/L)	(meq/L)	(meq/L)	(unitless)	(unitless)	Texture	(mg/kg)
Dewey[1]	0 - 11	1.22	6.8	1.6	4.4	2.8	6.3	3.19	3.33	C-CL-SiCL	16.8
	≈50	5.40	6.8	0.5	16.9	27.0	33.0	7.39	8.79	SiC-CL-C-SL	13.1
Dewey[3]	84	--[5]	--[5]	1.3	100.4	50.2	78.6	10.90	12.91	C	--[5]
Burdock[2]	0 - 11	1.64	7.3	1.8	8.2	4.1	5.3	1.91	1.53	C-CL-SiC	9.6
	≈50	5.98	7.7	0.7	24.5	34.7	37.5	6.16	7.26	C-CL-SiC-L	9.4
Burdock[4]	84	--[5]	--[5]	1.1	100.6	84.9	28.3	4.80	5.50	CL	--[5]

(1) Average of 18 values from auger cores. BKS Environmental Associates, Inc. (Oct. 7, 2008).
(2) Average of 19 values from auger cores. BKS Environmental Associates, Inc. (Oct. 7, 2008)
(3) Average of 3 values from test pits. Knight Piésold and Co. (2008)
(4) Average of 2 values from test pits. Knight Piésold and Co. (2008)
(5) -- means no data available.
(6) Calculated from average SAR.
(7) See Plate 2.5-1 for locations of auger cores, test pits, and irrigated areas.

4.2.2.1.2.3 Irrigation Water Properties

During land application, there could be potential impacts to the soil and crops from total dissolved solids (TDS) and electrical conductivity (EC) values in the water to be used to irrigate alfalfa or other crops as shown in Table 4.2-6. Pursuant to applicable standards, irrigation water quality is commonly assessed in terms of soluble salt content, percentage of sodium, boron, and bicarbonate contents. In the case of the water used for irrigation the soluble salts are on the order of 3,000 to 4,000 μS/cm at 25 °C. These levels pose low to moderate risk to the growth of moderately sensitive crops such as alfalfa and corn. The SAR levels are low and pose little risk to water erosion during the infiltration of rain or snowmelt. There could be some salt deposition at the surface, however maintaining maximum vegetative cover will reduce the possibility of undesirable species. During the irrigation season, water application rates will be adjusted to optimize both evaporation and crop production.

Table 4.2-6: SAR, ESP and RSC Calculations for Dewey and Burdock End-of-Production Ground Water Quality Assuming High Chloride Concentrations[4]

Constituent	Dewey (mg/L)	Dewey (meq/L)	Dewey ESP[1]	Dewey RSC[2]	Dewey SAR[3]	Burdock (mg/L)	Burdock (meq/L)	Burdock ESP[1]	Burdock RSC[2]	Burdock SAR[3]
CO_3	0.5	0.02				0.50	0.02			
HCO_3	25	0.41				25.00	0.41			
Cl	1,300	36.67				1,300	36.67			
SO_4	1,000	20.82				1,800	37.48			
Na	270	11.74				190	8.26			
Ca	730	36.43				970	48.40			
Mg	120	9.87	2.29	-45.87	2.44	220	18.09	0.85	-66.07	1.43
K	20	0.51				10	0.26			
Total Ion Bal.		0.54					0.29			
SAR (measured)	4.9					2.8				
pH (s.u.)	6.5-7.5					6.5-7.5				
TDS (mg/L)	4,500					4,500				
Spec. Cond. (µS/cm)	3,000					4,000				
As	0.01					0.01				
V	<10					6				

(1) ESP = Exchangeable Sodium Percentage. Empirical relationship from Withers and Vipond (1980).

$$ESP = \frac{100(-0.0126 + 0.01475 * SAR)}{1 + (-0.0126 + 0.01475 * SAR)}$$

(2) RSC = Residual Sodium Carbonate (meq/L). $RSC = ([CO_3] + [HCO_3]) - ([Ca] + [Mg])$

(3) SAR = Sodium Adsorption Ratio. $SAR = \frac{[Na]}{\sqrt{([Ca] + [Mg])/2}}$

(4) Estimated by Powertech (USA) based on results of laboratory scale leach tests conducted on ore samples from the Fall River and Lakota sites, as well as from historical end-of-production water quality data from other ISL sites in Wyoming and Nebraska, with adjustments as necessary to account for planned post-production water treatment(s).

Table 4.2-7 provides the estimated water quality to be applied to crops at both the Dewey and Burdock land application sites. It is anticipated that trace metal concentrations will be at or below EPA Primary Drinking Water Standards. In addition, the effluent concentration limits for the release of radionuclides to the environment as contained in 10 CFR Part 20, Appendix B will be met.

Table 4.2-7 Estimated Land Application Water Quality

Analyte	Units	Dewey Land Application Estimate	Burdock Land Application Estimate
pH	s.u.	6.5 - 7.5	6.5 - 7.5
Eh	mV	350	350
cond.	mS/cm	3	4
Major Ions			
Bicarbonate	mg/L	<50	<50
Calcium	mg/L	270	330
Carbonate	mg/L	<1	<1
Chloride	mg/L	300 - 1300	300 - 1300
Sodium	mg/L	270	190
Sulfate	mg/L	1000	1800
Solids	mg/L	4000 - 5000	4000 - 5000
Minor Ions			
Arsenic	mg/L	0.01	0.01
Barium	mg/L	0.42	0.42
Cadmium	mg/L	0.34	0.34
Chromium	mg/L	0.38	0.38
Copper	mg/L	0.28	0.28
Iron	mg/L	1.1	0.2
Lead - 210	mg/L	<10	<10
Magnesium	mg/L	120	220
Molybdenum	mg/L	<0.1	<0.1
Nickel	mg/L	340.34	340.34
Potassium	mg/L	20	10
Radium - 226	pCi/L	<60	<60
Selenium	mg/L	<0.2	<0.2
Thorium 230	pCi/L	<100	<100
U - Nat	pCi/L	<300	<300
Uranium	mg/L	<0.2	<0.2
Vanadium	mg/L	<10	<10
Sodium Absorption Ratio		4.9	2.8
Cations	meq/L	36	43
Anions	meq/L	30	47
Zinc	mg/L	-	-
A/C balance	%	8	-4
TDS Calc.	mg/L	2043	2908

Notes: 1) Estimates of land application water quality were based on the results of laboratory scale leach tests conducted on ore samples from the Dewey (Fall River) and Burdock (Lakota) sites, as well as from historical end - of - production water quality data from other ISL sites in Wyoming and Nebraska, with adjustments as necessary to account for planned post - production water treatments.
2) For the anion computation, a chloride concentration of 300 mg/L was used.
3) For the calculated TDS computation, a chloride concentration of 800 mg/L was used.

4.2.2.1.3 Modeling Approach

The general assumptions for the SPAW model include the following:

1. The model is a one-dimensional vertical model.
2. The model assumes that the modeled area is spatially uniform in soil, crop and climate characteristics.
3. Model inputs and outputs are based on daily values.
4. The model does not does not include flow routing or channel descriptors.
5. Daily runoff is estimated as an equivalent depth over the simulation field by the USDA/SCS Curve Number method.
6. The field budget utilizes a one-dimensional vertical system beginning above the plant canopy and proceeding downward through the soil profile to a depth sufficient to represent the complete root penetration and subsurface hydrologic processes (lateral soil water flow is not simulated).

Specific assumptions related to this project are as follows:

7. Daily precipitation and temperature data used in the model are based on 28 years of record from the Edgemont, South Dakota station.
8. SPAW modeling was done for two land application and pond areas, the Dewey site and the Burdock site.
9. Soils data used in the modeling of the Dewey site was based on a composite of soils data from Test Pits 1, 2 and 5.
10. Soils data used in the modeling of the Burdock site was based on a composite of soils data from Test Pits 8, 9 and 10.
11. The 24/7 year-round inflow rate from process water and bleed water at each site is 310 gpm.
12. The growing and irrigation season is from May 11 to September 24 each year (137 days).
13. Two cuttings of alfalfa are assumed during the growing season.
14. The irrigation water will be applied during the growing season at a rate that balances the total annual amount of process inflow water (approximately 850 gpm for 136 days).

15. All irrigation tailwater and rainfall runoff from the land application areas will be collected and returned to the storage impoundments.

16. The impoundments are designed to contain the one percent exceedance probability event (100-year event) plus 3 feet of freeboard.

17. All storage impoundments have side slopes of 3 to 1 and are 30 feet deep.

The objective of the SPAW modeling was to help design a land application system that: (1) maximizes evapotranspiration; (2) minimizes surface runoff; (3) minimizes percolation below the rooting zone; (4) minimizes the irrigated acreage required; and (5) minimizes the required volume of the storage ponds while maintaining a one percent probability that the design pond volume will be exceeded during the operating life of the facility.

SPAW modeling was performed at both the Dewey and Burdock sites. A composite of the soil properties at each site was created for use in the model using analytical data from three test pits from each site. Test pits 1, 2 and 5 were used for the Dewey site and test pits 8, 9 and 10 were used for the Burdock site. The composites were created by taking the averages of the gravel, sand and clay fractions and the dry bulk densities for each depth interval for the three test pits at each site.

The SPAW modeling assumed that the facility will operate on a year-round basis for 15 years. Twenty-eight years of daily precipitation, temperature and evaporation data from January 1, 1980 to December 31, 2007 were used to create 28 unique and equally likely simulations of the process water balance. Each simulation used 15 years of sequential climatic data corresponding to the 15 years of operation of the facility. The climatic data intervals used for each of the 28 simulations are shown in Table 4.2-8.

Field simulations using the SPAW model were run using each of the 28 climatic data intervals shown in Table 4.2-8. The results of these field simulations were used as the input to pond simulations for the same 28 climatic intervals. The result was a daily pond volume for each day of the year for each of the 28 15-year simulations.

Two methods were then used to estimate the pond volume with a 1 percent exceedance probability during a 15-year operating period. In the first method, the average pond volume for each day of the year for the 28 simulations was calculated. Then, the pond volume for each day of the year with a 1 percent exceedance probability was calculated using the Gumball Extreme

Value distribution, which resulted in 365 possible values. The greatest of these 365 values was then selected as the volume with a 1 percent exceedance probability during a 15-year period.

Table 4.2-8: Sequential Water Balance Simulations

Simulation No.	15-Year Climatic Data Interval
1	01/01/1980 to 12/31/1994
2	01/01/1981 to 12/31/1995
3	01/01/1982 to 12/31/1996
4	01/01/1983 to 12/31/1997
5	01/01/1984 to 12/31/1998
6	01/01/1985 to 12/31/1999
7	01/01/1986 to 12/31/2000
8	01/01/1987 to 12/31/2001
9	01/01/1988 to 12/31/2002
10	01/01/1989 to 12/31/2003
11	01/01/1990 to 12/31/2004
12	01/01/1991 to 12/31/2005
13	01/01/1992 to 12/31/2006
14	01/01/1993 to 12/31/2007
15	01/01/1994 to 12/31/1980
16	01/01/1995 to 12/31/1981
17	01/01/1996 to 12/31/1982
18	01/01/1997 to 12/31/1983
19	01/01/1998 to 12/31/1984
20	01/01/1999 to 12/31/1985
21	01/01/2000 to 12/31/1986
22	01/01/2001 to 12/31/1987
23	01/01/2002 to 12/31/1988
24	01/01/2003 to 12/31/1989
25	01/01/2004 to 12/31/1990
26	01/01/2005 to 12/31/1991
27	01/01/2006 to 12/31/1992
28	01/01/2007 to 12/31/1993

In the second method, the 24-hour 100-year rainfall amounts for each month were calculated from the 28 values of daily data for each month using the Gumball Extreme Value Distribution. These values are shown in Table 4.2-9.

Table 4.2-9: 24-Hour 100-Year Monthly Precipitation at Edgemont, SD Station

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.57	0.88	1.97	3.41	2.31	3.83	3.83	2.86	3.11	2.48	1.32	0.96

The 24-hour 100-year runoff volume for each month was then calculated for the irrigated area contributing to the pond using the USACE HEC-1 model. These runoff volumes were then added to the average daily values of pond volume for each month for the 28 simulations. The maximum of the 365 values obtained in this way was compared to the maximum value obtained using the first method. The greater of these two values was selected as the pond volume with a one percent exceedance probability during a 15-year period.

4.2.2.1.4 Model Results

Field Model Results

Based on the SPAW modeling, the total irrigated area at any given time at the Dewey site would be 375 acres, consisting of six 50-acre pivots plus three 25-acre pivots. In addition, there would be one 50-acre pivot and one 25-acre pivot on standby (total pivots at Dewey is seven 50-acre pivots and four 25-acre pivots). Pumping at Dewey would occur for 24 hours every day during the growing season (May 11 to Sept 24). Pumping rates at Dewey would be 113 gpm on each 50-acre pivot and 57 gpm on each 25-acre pivot. This equals a total of 849 gpm pumped for 24 hours on every day of the growing season at Dewey.

The total irrigated area at any given time at the Burdock site would be 500 acres (eight 50-acre pivots plus four 25-acre pivots). In addition, there would be four 25-acre pivots on standby (or any combination of pivots equal to 100 acres capacity). The total pivots at Burdock would be eight 50-acre pivots and eight 25-acre pivots. Pumping at Burdock would also occur for 24 hours on every day of the growing season (May 11 to Sept 24). Pumping rates at Burdock would be 85 gpm on each 50-acre pivot and 42.5 gpm on each 25-acre pivot. This equals a total of 849 gpm pumped for 24 hours on every day of the growing season.

The annual summaries of the SPAW field modeling results for the twenty-eight 15-year simulations at both the Dewey and Burdock sites are shown in Appendix 4.2-A. The center pivot areas at both the Dewey and Burdock sites are shown on Figure 2.1-1.

Pond Model Results

Based on the assumptions listed above (Section 4.2.2.1.3), the model results showed that the total pond volume having a 1-percent exceedance probability is 536 acre-feet for the Dewey site. Four lined impoundments (ponds), each with dimensions of 560 feet x 560 x 33 feet deep and a capacity of 157 acre-feet, will be constructed at Dewey, providing a total capacity of 628 acre-feet. This capacity includes the volume with a 1 percent exceedance probability, plus 3 feet of freeboard. Each pond will be constructed with leak detection, and will have sufficient capacity for the settling of barium sulfate and radium, the total volume of which over the 15-year operating life is estimated to be .036 acre-feet.

The model showed that the total pond volume having a 1-percent exceedance probability is 653 acre-feet for the Burdock site. Six lined impoundments (ponds), each with dimensions of 560 feet x 560 x 33 feet deep and a capacity of 157 acre-feet, will be constructed at Burdock. Five of the ponds will be operational at any given time and one will be a backup pond. The 5 operational ponds will provide a total capacity of 785 acre-feet, which includes the volume with a 1 percent exceedance probability, plus 3 feet of freeboard. The annual summaries of the SPAW pond modeling results for the twenty-eight 15-year simulations at both the Dewey and Burdock sites are shown in Appendix 4.2-A.

In addition there will be a CPP pond at the Burdock site for storing process water prior to treatment. The CPP pond will be 380 feet x 380 feet x 33 feet including 3 feet of freeboard, with a total capacity of 63 acre-feet.

4.2.2.1.5 Land Application Monitoring

The land application system will be monitored for environmental effects and to track system performance. A general summary of system monitoring is described in the following section. A detailed description of the system monitoring plan is contained in the "Operations and Monitoring Management Plan" (Knight Piésold, 2008). The following types of samples will be collected for laboratory analysis:

- Supplemental freshwater (if needed)
- Land applied process water
- Air
- Soil
- Biomass
- Surface Water
- Groundwater

The parameters for analysis of each sample type (water, soils, vegetation and air) will be in accordance with the operational radiological monitoring program provided in RG 4.14 and selected parameters listed in Table 4.2-7.

4.2.2.1.5.1 Supplemental Freshwater

In the event that supplemental freshwater from wells or other sources is used to supplement the water from the settling ponds for land application, grab samples of this supplemental freshwater will be collected monthly during the irrigation season (May 11 to September 24). The parameters for analysis will be in accordance with the operational radiological monitoring program provided in RG 4.14 and selected parameters listed in Table 4.2-7.

Samples will be collected at the freshwater discharge source.

4.2.2.1.5.2 Land Applied Process Water

Grab samples of land applied process water will be collected monthly from a point in the distribution system downstream from the settling ponds and the parameters for analysis will be in accordance with the operational radiological monitoring program provided in RG 4.14 and selected parameters listed in Table 4.2-7.

4.2.2.1.5.3 Air

Locations of air monitoring stations are shown in Figure 2.9-8. The filters from air samplers operating continuously will be analyzed for at least two quarters prior to the beginning of operations, and then quarterly for the parameters provided in RG 4.14. The samplers will have sensors to measure total air flow within a sampling period. Passive track-etch detectors will be deployed at each station for monitoring radon-222 on a quarterly basis.

4.2.2.1.5.4 Soil

One sample of surface soil (0-15 centimeters) from within each pivot area (27 samples total) will be collected prior to the beginning of operations, and then at the end of each irrigation season after operations begin. The parameters for analysis will be in accordance with the operational radiological monitoring program provided in RG 4.14 and selected parameters listed in Table 4.2-7. Two suction lysimeters will be placed in each of the center pivot circles shown on Figure 2.1-1 at both the Dewey and Burdock sites to obtain pore water samples for the physical/chemical analyses provided in RG 4.14 and selected parameters listed in Table 4.2-7. One lysimeter will be place at a depth of 1 foot below ground surface and the other at a depth of

3 feet below ground surface at each irrigation circle. Pore water samples will initially be taken twice during the irrigation season and once before and after the irrigation season. Measurements of soil moisture from soil samples will be made monthly at the same irrigation circle locations during the irrigation season and bi-monthly during the remainder of the year. Supplemental measures of hydraulic conductivity may be done if it appears to change during the operation of the irrigation systems.

4.2.2.1.5.5 Biomass

Samples of the alfalfa grown on 3 of the land application areas at Dewey and from 4 of the areas at Burdock will be collected at the end of each irrigation season during operations. Samples of livestock that have been fed alfalfa grown at the PAA during operations will be collected once per year, shortly after slaughter. The samples of vegetation and livestock will be analyzed for the parameters provided in RG 4.14.

4.2.2.1.5.6 Surface Water

Surface water samples will be collected at previously established monitoring points shown on Figure 5.7-1. Samples will be collected quarterly at each of the monitoring stations and analyzed for the parameters provided in RG 4.14 and selected parameters listed in Table 4.2-7.

4.2.2.1.5.7 Groundwater

Groundwater samples will be collected quarterly from the well locations shown in Figure 5.7-1, to monitor groundwater quality and potential releases from the settling ponds. These samples will be analyzed for the parameters provided in RG 4.14 and selected parameters listed in Table 4.2-7.

All sampling activities will be conducted in accordance with an approved quality assurance/quality control plan. Records of all sampling activities and laboratory analyses will be maintained and periodic reports of all sampling and analyses will be submitted to the South Dakota Department of Environment and Natural Resources (DENR).

4.2.2.2 Waste Disposal Well

The use of waste disposal well alone or in combination with land application is also being considered by Powertech (USA) to dispose of liquid waste. Powertech (USA) is currently investigating suitable zones for deep well injection within the proposed action area, to the west of the Dewey-Burdock site in the Powder River Basin of Wyoming and to the south in northwestern Nebraska. The permitting of the wells will meet the criteria and standards promulgated by the Environmental Protection Agency under the regulatory provisions of 40 CFR Part 146, Underground Injection Control Program.

The physical and chemical properties of the wastes will be similar to the estimated quality of wastes provided in Tables 4.2-6 and Table 7.3-8 for land application. The process waters for deep well injection will meet the regulatory provisions in 10 CFR 20.2002 and be within the dose limits in 10 CFR 20.1301.

4.2.3 Potential Pollution Events Involving Liquid Waste

Although there are potential sources of pollution at the project facility, Powertech's (USA) Environmental Management Programs combined with existing regulatory requirements from the NRC and DENR establish a framework that significantly reduces the possibility of an event. Additionally, extensive personnel training, which is standard policy for all Powertech (USA) operations, will be implemented at the project. Detailed procedures for inspections of waste management facilities and systems will be included in Powertech's (USA) Environmental Management Programs, which will be tailored for use at the project.

The following represent potential sources of pollution:

- Spills from well field buildings, pipelines, and well heads
- CPP and SF
- Deep well pump houses and well heads
- Domestic liquid waste

4.2.3.1 Spills from Well Field Buildings, Pipelines, and Well Heads

There will be no process chemicals or effluents stored within well field buildings or pipelines. As such, they are not considered to be a potential source of pollutants during normal operations. However, these well field features could contribute to pollution in the unlikely event of a release of injection or recovery solutions due to pipe or well failure. The chances of such a failure are minimized by leak checking the piping prior to installation. Additionally, the flows through the pipe will be at a relatively low pressure and can easily be stopped, further reducing the chance of a spill migrating far from the source. Well field header houses will be equipped with wet alarms for early detection of leaks, further minimizing the potential for a large event. Due to a decrease in flow and pressure, large leaks in the pipe would quickly become apparent to the plant operators, and the release could be mitigated rapidly. All piping will be leak checked prior to installation and operation.

Generally, piping from the plant either to or within the well field will be constructed of PVC or high density polyethylene (HDPE) with butt welded joints or equivalent. All pipelines will be pressure tested before initial operation, and it is unlikely that a break would occur in a section of underground pipe as no additional stress is placed on the pipe. Piping from the well fields will generally be buried, minimizing the possibility of an accident resulting in an event. Additionally, underground pipelines will further be protected from vehicles driving over the lines, which is a major source for potential failure. Typically, the only exposed pipes will be at the CPP, wellheads, and in the header houses in the well field, where trunk line flows and manifold pressures will be monitored for process control.

Engineering and administrative controls at the CPP will help to prevent both surface and subsurface releases to the environment, and to mitigate the effects should an accident occur.

4.2.3.2 Central Processing Plant

The CPP will serve as the hub for production operations at the project; therefore, the CPP will likely have the greatest potential for spills or accidents potentially resulting in the release of pollutants. Spills at the CPP could result from a release of process chemicals from bulk storage tanks, or from structural failure of either piping or bulk storage tanks.

Chemical storage tanks outside will be contained within a curbed area designed to accommodate 1and one half the capacity of the largest tank to ensure containment during a potential precipitation event. Fuel storage tanks will be contained within concrete lined and fenced storage facility to prevent potential impacts to the surface.

The CPP will be designed such that any release of liquid waste would be contained within the structure. A concrete curb will be built around the entire process building and will be designed to contain the contents of the largest tank within the building in the event of a rupture. The pumping system will immediately be shut down in the event of a piping failure, limiting any further release. Liquid inside the CPP building, from either a spill or from washdown water, will be drained through a sump and then sent to the liquid waste system for disposal or treatment and land application.

4.2.3.3 Waste Disposal Well Pumphouses and Wellheads

Waste disposal well pumphouses and wellheads will be designed such that any release of liquids will be contained within the building or the bermed containment area surrounding the facilities. Liquid inside the building will be contained and then recycled to the liquid waste system.

4.2.3.4 Domestic Liquid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the DENR. These systems are commonly used throughout the United States and the effect of the system on the environment is known to be minimal.

4.3 Transportation Vehicles

An accident involving transportation vehicles to and from the project site could potentially release pollutants to the environment. Transport vehicles at the project site include, but are not limited to: vehicles delivering bulk chemical products, transport of radioactive contaminated waste from the project site to an approved disposal site, or transport of waste brines from the CPP, or from vehicles carrying dried yellowcake product from the CPP.

Chemicals and products delivered to or transported from the project site will be transported in accordance with all SDDOT regulations. As part of Powertech's (USA) Environmental Management Program, emergency response procedures will be developed and implemented to ensure a rapid response to any transportation incidents. All appropriate personnel will be appropriately trained in emergency response procedures to facilitate proper response from Powertech (USA) employees in transportation incidents.

4.4 Solid Waste and Contaminated Equipment

4.4.1 Radioactive Wastes

Solid radioactive waste generated at the site is expected to include impounded 11e.(2) byproduct material extracted directly from the ISL process (radium removal and reverse osmosis units, spent resins, etc) as well as material contaminated with radionuclide by-products (miscellaneous pipe, pumps, fittings and similar items contaminated with low levels of radioactive "scale" and precipitates). The radiological contaminant will be primarily residual natural uranium and radium 226 (NMA 2007, Brown 2007, 2008). As radium will follow the process calcium chemistry, process pH and related chemical parameters will play a role in determining where and how much residual by-product material becomes deposited in process components. Mobilization of other uranium series radionuclides (Th 230, Pb 210) has been indicated to be minimal (Brown 1982). Two categories of radioactive solid waste (i.e., "11e.(2) by-product material") are discussed, impounded by-product material extracted directly from the process and equipment contaminated with by-product material.

4.4.1.1 Impounded Byproduct Material

Small volumes of solid radioactive wastes are typically generated at ISLs and need to be temporarily impounded at designated on-site locations pending further evaluation and/or shipment offsite. Temporary impoundment on-site typically involves designated ponds and/or tankage. Alternatively, the material may be drummed as produced.

These wastes result primarily from spent resins and process sludges, including pond sludges, reject streams/brine from reverse osmosis (RO) units, solid slurry precipitates from brine concentrators, spent sand and/or Cuno filters, filter back flush from similar process stream "polishing" activities and potentially small amounts of contaminated soil from leaks and/or spills.

Byproduct material requiring offsite disposal in accordance with NRC requirements and/or license conditions will be transported off site to an NRC or Agreement State licensed 11e.(2) disposal facility. Prior to transportation to a licensed disposal facility, byproduct material will be stored in designated storage buildings (also referred to as "byproduct storage buildings"), one located at the CPP site and one located at the SF site. These buildings will consist of a concrete slab with a containment curb surrounding the perimeter. Storage of byproduct material will be within "roll-off" containers (bins) which are both liquid tight and fully enclosed. As each storage building can accommodate two 20 cubic yard bins, the volume of byproduct material could accumulate to 30 to 40 cubic yards at each of the two storage locations prior to transport. There are two bays in each storage building, each accessed by an overhead roll-up door and allowing exchange of containers necessary for transport to a licensed 11e(2) disposal site. The concrete slabs will be designed to allow external decontamination of the roll-off bins prior to transport.

The byproduct storage buildings will allow for control of byproduct materials and specific segregation of these wastes from other non-11e(2) wastes. Typically these wastes are expected to consist of contaminated used equipment parts, personal protective equipment, and wastes from cleanup of spills or other housekeeping activities. Other waste not in contact with the uranium production process will be disposed of in regular dumpsters situated at a separate location.

Containment of these byproduct wastes within a designated, fully enclosed building will allow for proper control of the materials, monitoring, and necessary restricted access. These measures will ensure best possible control of 11e(2)solid and liquid wastes to minimize any potential exposures or contamination.

Powertech (USA) estimates that the proposed project will produce approximately 100 yd^3 of solid or sludge 11e.(2) byproduct material per year from the radium ponds and from miscellaneous supplies. These materials will be stored on-site, properly labeled and posted inside the restricted area until such time that a full shipment can be transferred to a licensed 11e.(2) waste disposal site or licensed mill tailings facility in accordance with the requirements of the NRC.

4.4.1.2 Contaminated Equipment

This category of solid radioactive waste includes process and other ancillary equipment and materials that have become contaminated with low levels of by-product materials as a result of use and/or contact with process streams. Equipment and materials generated by this project that may become contaminated with by-product materials include items such as rags, trash, worn or replaced parts from equipment, piping, fittings, pumps, filters, protective clothing, etc. In some cases, reusable items with economic value (e.g., tools) may be decontaminated prior to release from the restricted area. If decontamination of equipment is deemed desirable and practical, surveys for residual surface contamination will be made before releasing the material from the restricted area. Decontaminated materials must have activity levels lower than those specified in Table 2 of NRC Regulatory Guide 8.30 (NRC, 2002).

4.4.2 Hazardous Waste

The potential exists for any industrial facility to generate hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). On the basis of the processes and materials to be used on the project, it is likely that this project will be classified as a Conditionally Exempt Small Quantity Generator (CESQG), defined as a generator that generates less than 100 kg of hazardous waste in a calendar month and that complies with all applicable hazardous waste program requirements. In the event that Powertech (USA) is not classified as a CESQG, Powertech (USA) will obtain the appropriate approvals or permits. Powertech (USA) expects that only used waste oil and universal hazardous wastes such as cleaning solvents and spent batteries will be generated at the project.

4.5 Reference

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5.0 Operations

During operation of the facility, Powertech (USA) via the company's Safety and Environmental Review Panel (SERP) will ensure that the facility will apply to all applicable laws and regulations. Powertech (USA) will also maintain the health and safety of the workers, general public, and the environment while the facility is in operation. This includes maintaining potential occupational and public exposures to ionizing radiation as low as reasonably achievable (ALARA).

5.1 Corporate Organization and Administrative Procedures

This section provides functional positions within the Powertech (USA) organization that have direct responsibility to ensure corporate commitment to operating the facility in a manner that is protective of human health and the environment, including the principle of ALARA. The organizational accountability of these functional positions is also presented.

5.1.1 Corporate and Facility Organization

The organizational structure of Powertech (USA) and the facility is shown in Figures 5.1-1 and 5.1-2, respectively. The organization structure defines Chief Operating Officer (COO) as having direct supervision over the Vice President of Environment, Health, and Safety and the Mine Manager of the facility.

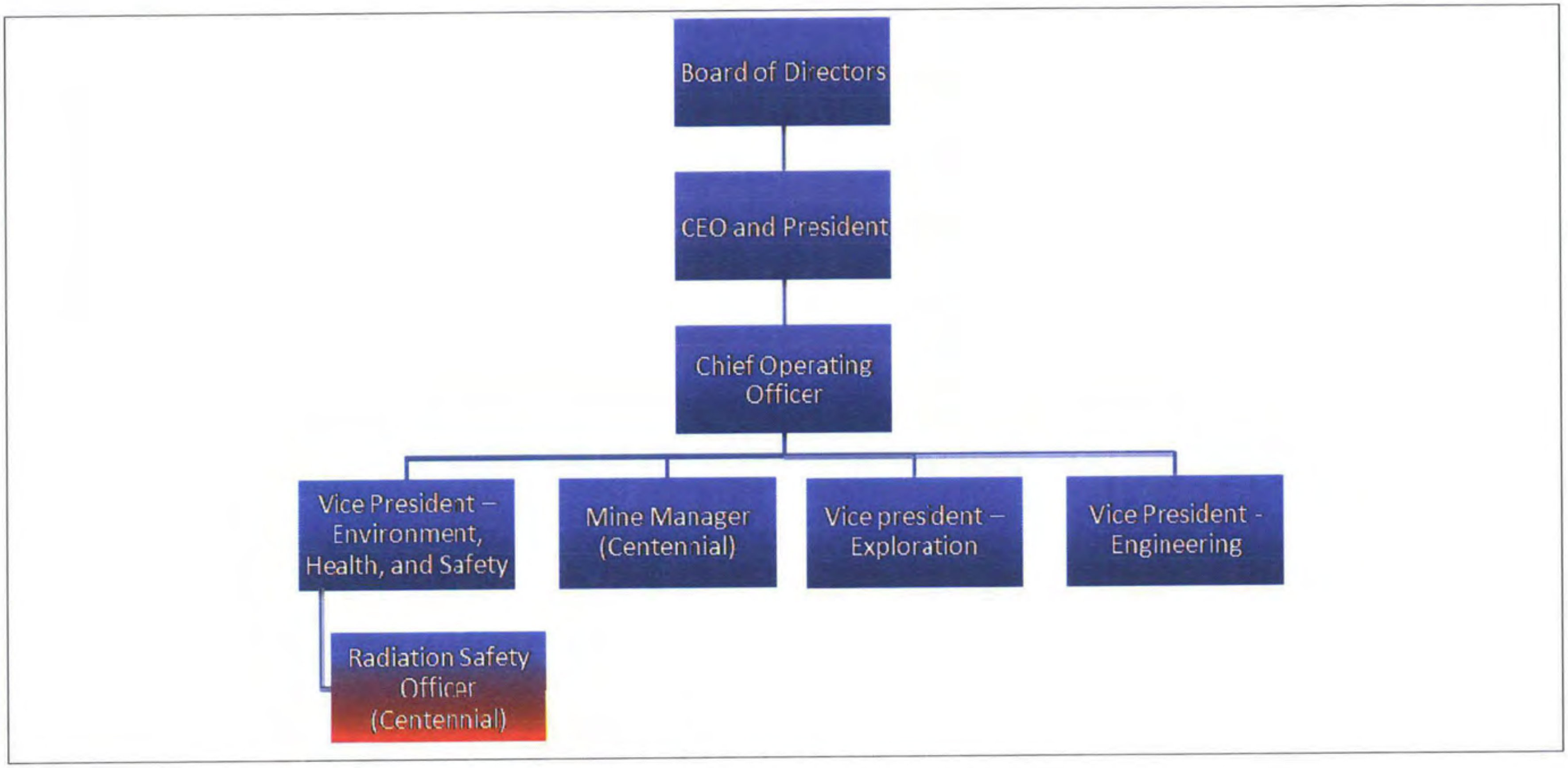

Figure 5.1-1: Organizational Structure

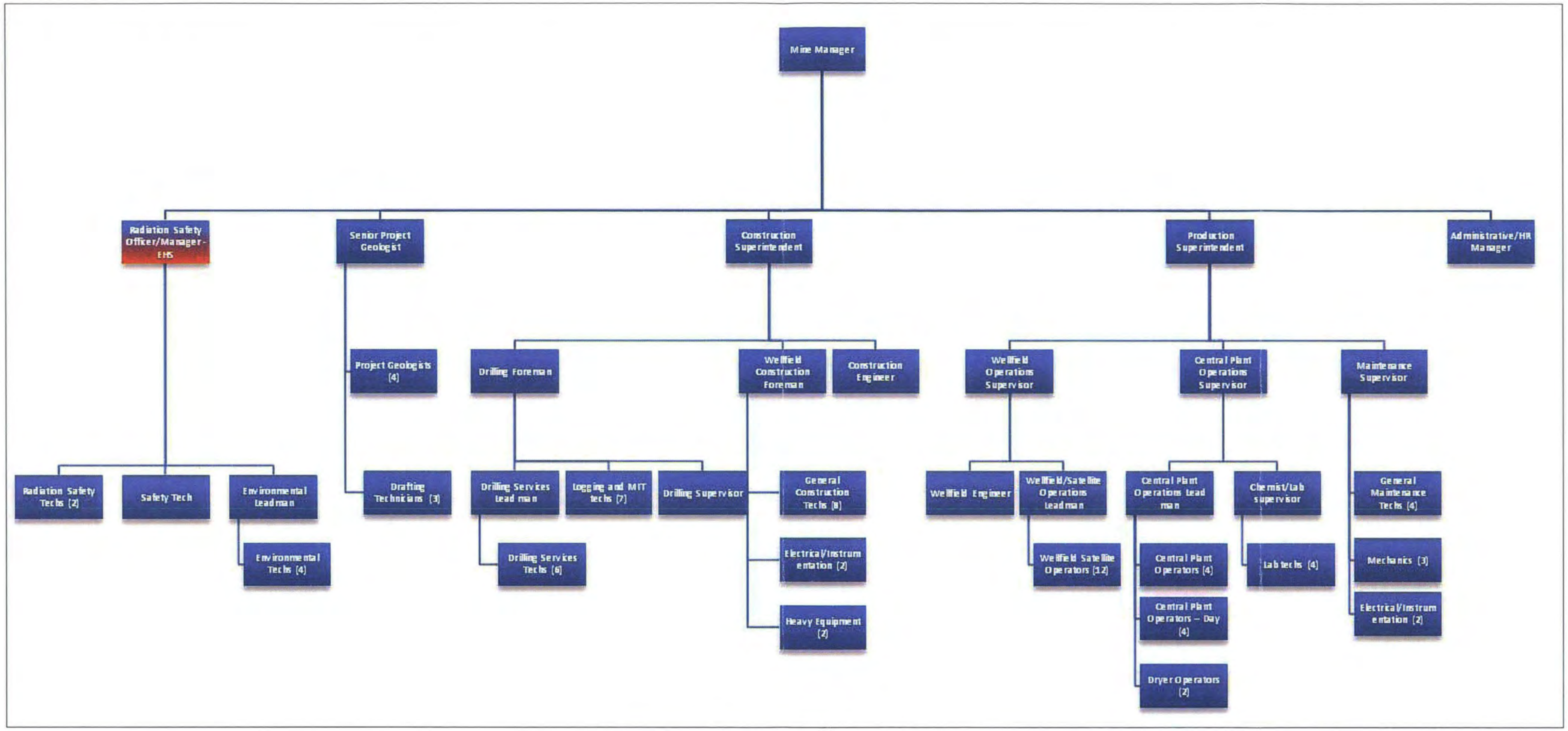

Figure 5.1-2: Facility Organizational Structure

5.1.2 Chief Operating Officer

The COO is empowered by the Board of Directors to have the responsibility and authority for the radiation safety and environmental compliance programs at all Powertech (USA) facilities. The COO is directly responsible for ensuring that Powertech (USA) personnel comply with corporate industrial safety, radiation safety, and environmental protection programs. The COO is also responsible for company compliance with all regulatory license conditions/stipulations, regulations, and reporting requirements. The COO has the responsibility and authority to terminate immediately any activity that is determined to be a threat to employees, public health, or the environment, or a violation of state or federal regulations. The COO has the authority to assign corporate resources (e.g. capital equipment, personnel, budget) to ensure corporate environmental, health, and safety goals and directives are met.

5.1.3 Vice President of Environment, Health, and Safety

The Vice President of Environment, Health, and Safety is responsible for all radiation protection, health and safety, and environmental programs for Powertech (USA) and ensuring these programs meet applicable regulatory requirements and industry best management practices. The Vice President is responsible for ensuring that all company operations comply with all applicable laws and regulations. The Vice President reports directly to the COO.

5.1.4 Mine Manager

The Mine Manager will be responsible for all operations at the project facility. The Mine Manager will be responsible for compliance with all applicable laws and regulations as well as corporate health, safety and environmental programs. The Mine Manager will have the authority to terminate immediately any operation of the facility that is determined to be a threat to employees, public health, or the environment, or a violation of laws or regulations. The Mine Manager reports directly to the COO. The Mine Manager has the authority to assign facility resources (e.g. capital equipment, personnel, budget) to ensure corporate environmental, health, and safety goals and directives are met. The Mine Manager will act promptly on recommendations made by the Radiation Safety Officer to correct deficiencies identified in the radiation or environmental monitoring programs.

5.1.5 Radiation Safety Officer

The Radiation Safety Officer (RSO) will be the person in charge of and responsible for the radiation protection and as low as reasonably achievable (ALARA) program. The RSO will ensure that equipment and laboratory facilities are adequate for monitoring and evaluating the relative attainment of the ALARA objective. The RSO will develop, review, and enact changes in the program so that protection against uranium and its progeny and the ALARA principle are maintained during the operation of the facility. These changes include new equipment, process changes, and changes in the operating procedures.

The RSO will also have the authority to enforce regulations and administrative policies that affect the program and can raise issues concerning safety to Mine Manager and the Vice President of Environment, Health, and Safety as shown in Figures 5.1-1 and 5.1-2. The RSO will also be a member of the SERP described in Section 5.2.3 and will meet the qualifications outlined in NRC guidance.

The RSO reports directly to the Vice President of Environment, Health, and Safety.

5.2 Management Control Program

This section describes administrative controls within the Powertech (USA) organization that are intended to ensure the facility is operated in a manner that is protective of human health and the environment, including the principle of ALARA.

5.2.1 Routine Activities

All routine activities involving handling, processing, or storing of radioactive material at the Dewey-Burdock facility will be documented by written standard operating procedures (SOPs). In addition, written SOPs will be established for health physics monitoring, sampling, analysis, and instrument calibration. These SOPs involving radioactive material handling will incorporate pertinent radiation safety practices.

Each SOP will be reviewed and approved in writing by the RSO or the RSO designee prior to implementation. Any proposed changes to an SOP must also be reviewed and approved in writing by the RSO or the RSO designee. The RSO will review each SOP at least annually to ensure it follows any newly established radiation protection practices.

Up-to-date copies of the SOPs, along with accident response and radiological fire protection plans, will be made available to all employees. All SOPs will be managed in a manner which allows for tracking of revisions and dates of the revisions.

5.2.2 Non-Routine Activities

Any activities with potential for significant exposure to radioactive material and not documented by existing SOPs will require radiological work permits (RWPs). RWPs are job-specific permits that describe the following:

1. The details of the job to be performed,
2. Precautions necessary to maintain radiation exposures ALARA, and
3. The radiological monitoring and sampling necessary before, during, and following completion of the job.

The RSO or the RSO designee must review and sign off on the RWP before the associated work is to be performed. That work will be executed to the details specified in the RWP.

5.2.3 Safety and Environmental Review Panel

A SERP will be established. The SERP will consist of at least three members. One member will be the RSO. Another member will be someone with authority to implement managerial and financial changes (e.g. the Mine Manager). Another member will be someone with authority to make operational changes (e.g. the Production Superintendent). The SERP may include others on a temporary or permanent basis whenever the SERP requires additional technical or scientific expertise and may be other employees or consultants. At least one member of the SERP shall be designated as chairman.

The purpose of the SERP will be to evaluate, discuss, approve, and record any changes to any SOP, the facility, or tests and experiments involving safety or the environment. The changes will not require a license amendment pursuant to 10 CFR 40.44 as long as the changes do not:

- Create a possibility of an accident unlike what is evaluated in the license application (as updated)
- Create a possibility of a malfunction of a structure, system, or control unlike what is evaluated in this license application (as updated)
- Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report or the environmental assessment or technical evaluation reports or other analyses and evaluations for license amendments

Records of the evaluations made by the SERP will be made. These records will provide the basis for determining if the implementations of the changes do not require a license amendment pursuant to 10 CFR 40.44. Any change approved by the SERP will be documented in writing by showing the affected operating procedure, facility, and/or test and experiment before and after the change along with the date of the change. Even though Powertech (USA) is a newly formed corporation, it possesses more than 200 years of technical experience with ISL operations. The SERP will evaluate each well field package as it is developed. Due to the fact that Powertech (USA) is seeking a performance based license from the NRC, the SERP will submit the first well field package to the NRC for review and evaluation.

The SERP will have the authority to raise issues regarding the health and safety of the workers, general public, and/or the environment due to the operation of the facility to the Mine Manager and the Vice President of Environment, Health, and Safety.

An annual report will be prepared which describes actions taken by the SERP including changes to operating procedures, the facility, or tests and experiments that involve safety or the environment enacted since the previous report was issued. The report will also document the reason for each change, whether the change required a license amendment, and the basis for determination.

5.2.4 Radioactive Material Postings

In order to be exempted from the requirements of 20 CFR 1902(e), all entrances to the facility will be conspicuously posted with the following statement: "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."

5.2.5 Record Keeping

All records will be maintained as hard copy originals or stored electronically.

The following information will be permanently maintained both on-site and at an off-site location until license termination:

- Records of on-site radioactive waste disposal.
- Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.
- Records of spills, excursions, facility stoppages, contamination events, and unusual occurrences.
- Records of inspections of tailings piles and waste retention systems.

- Records of the occupational monitoring described in Section 5.7.
- Information related to the radiological characterization of the facility.
- Drawing and photographs of structures, equipment, restricted areas, wellfields, and storage areas with radioactive materials and all of their modifications.

Additionally, records of survey and calibrations will be maintained for at least 3 years.

All records will be stored in manner to prevent record loss from fire, flood, or other unforeseen events beyond the control of Powertech (USA). All records will be legible throughout the retention period described above.

5.2.6 Reporting

Consistent with 10 CFR 20.2202, Powertech (USA) will notify the NRC within 4 hours of any event that could cause a release of licensed material or an exposure to radiation or radioactive materials exceeding the regulatory limits.

The NRC will be notified within 24 hours of any event that causes:

- An unplanned contamination event, involving licensed material greater than 5 times the lowest annual limit of intake, requiring longer than 24 hours to correct/clean up.
- Equipment necessary for control of radioactive material or radiation fails and there is no adequate redundancy/substitute.
- Medical treatment of an individual with removable contamination at an outside facility.
- An unplanned explosion/fire affecting the integrity of either a container of licensed material greater than 5 times the lowest annual limit of intake or the licensed material itself.

The NRC will be notified within 48 hours of any event in which spills, evaporation pond leaks, or excursions of source material and process chemicals occurred.

A written report will be made and sent to the NRC Headquarters Manager within 30 days of each event listed above. That report will contain details about the event including the conditions leading up to the event, corrective measures taken, and their results.

The following reports will be submitted to the NRC at the indicated frequency:

- Annually, a SERP report as described in Section 5.2.3.
- Semiannually, an effluent and environmental monitoring report as required by 10 CFR 40.65.
- Annually, the ALARA audit report detailed in Section 5.3.3.
- Annually, summary of monitoring data detailed in Section 5.7 and any corrective actions resulting from SERP actions, inspections described in Section 5.3 or reporting triggers described above.

5.3 Management and Audit Program

This section describes management and audit programs Powertech (USA) will use to periodically evaluate compliance with and effectiveness of the radiation protection, operational monitoring, and environmental programs at the facility. A series of health physics inspections and audits of the radiation protection and ALARA programs will be conducted.

5.3.1 Health Physics Inspections – Daily

The RSO or an RSO designee will conduct a daily visual inspection of all work and storage areas in the facility. The purpose of these inspections is to determine if good radiation practices are being implemented properly, including minimization of contamination through proper housekeeping and cleanup, SOPs are being followed, and if issues identified in prior inspections have been addressed and corrected.

5.3.2 Health Physics Inspections – Weekly

Once a week, the RSO and Mine Manager will perform an inspection of all facility areas. The purpose of these inspections is to examine the general radiation control practices and observe the required changes in procedure and equipment.

Procedural deviation or other issues potentially affecting facility compliance, health and safety, or environmental impacts found during the inspections will be recorded in an inspection logbook or equivalent tracking system along with the date of the inspection and the signature of the inspector. These entries will be kept on file for at least a year. The RSO will discuss the problems with members of management that have the authority and responsibility to rectify them.

Additionally, the RSO will review the shift logs and daily work-orders, on a regular basis, where there was potential of exposing employees. The RSO will determine if each action was authorized in writing by a person with the proper authority (the RSO or someone designated by the RSO).

5.3.3 Health Physics Reviews – Monthly

At least monthly, the RSO will review the results of daily and weekly inspections, including a review of all monitoring and exposure data for the month. The RSO will then write a report summarizing the significant worker protection activities for the month. The report will summarize the most recent personnel exposure data, bioassays, and time-weighted calculations for the month along with the pertinent radiation survey records for the month.

Additionally, the monthly reports will discuss any trends or deviations from the radiation protection and ALARA program, including an evaluation of the adequacy of the implementation of license conditions regarding radiation protection and ALARA. The reports will also provide a description of unresolved issues and the proposed corrective measures. Monthly summary reports will be submitted to the Mine Manager and made available to the Senior Project Geologist, Construction Superintendent, Production Superintendent, and Administrative/HR Manager. These monthly RSO reports will be maintained on file and readily accessible for at least 5 years.

5.3.4 Annual Radiation Protection and ALARA Program Audit

The ALARA and radiation protection program will undergo audits annually. The audits will be performed by a team consisting of people who are knowledgeable about the radiation protection program at the facility. One team member will be experienced in the operational aspects of radiation protection practices specific to uranium recovery facilities. The RSO will not be a member of the audit team but will be available to support the team and provide needed information.

A written report of the audit will be sent to the Vice President of Environment, Health, and Safety and Mine Manager. At a minimum, the reports will summarize the following data:

- Employee exposure records (external and internal)
- Bioassay results
- Inspection log entries and summary reports of daily, weekly, and monthly inspections
- Documented training program activities

- Radiation safety meeting reports
- Radiological survey and sampling data
- Reports on overexposure of workers submitted to the NRC
- Operating procedures that were reviewed during this time period

Also, the reports shall include the following:

- Trend evaluation of personnel exposures for identifiable categories of workers and types of operational activities
- Assessment of whether equipment for exposure control is being properly used, maintained, and inspected
- Recommendations on ways to further reduce personnel exposures from uranium and its progeny

5.4 Qualifications for Personnel Implementing the Radiation Safety Program

The minimum qualifications for the RSO are:

- A bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in radiation protection at a uranium recovery facility. Two years of relevant experience will generally be considered equivalent to one year of academic study.
- At least one year of uranium recovery work experience in applied health physics, radiation protection, industrial hygiene, or similar area. This experience should involve hands-on work with radiation detection and measurement equipment, not strictly administrative work.
- At least four weeks of specialized classroom training in health physics.
- A thorough knowledge of the health physics instrumentation used in the facility, the chemical and analytical procedures used for radiological sampling and monitoring, methods used to calculate personnel exposure to uranium and its progeny, the uranium recovery process, and the facility hazards and their controls.

The minimum qualifications for a Health Physics Technician are one of the following combinations:

- An associate's degree or two or more years of study in the physical sciences, engineering, or a health-related field; at least four weeks of generalized training in radiation health protection applicable to uranium recovery facilities (up to two weeks may be on-the-job training); one year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures that apply to uranium recovery facility operations.

- A high school diploma; at least three months of specialized training in radiation health protection relevant to uranium recovery facilities (up to one month may be on-the-job training); two years relevant work experience in applied radiation protection.

5.5 Radiation Safety Training

This section describes minimal training requirements to ensure all employees and visitors have an adequate level of knowledge to recognize and are aware of potential radiological hazards associated with activities they will be involved with at the facility.

5.5.1 Initial Training

Prior to working at the facility, all facility workers and supervisors subject to occupational radiation dose limits (i.e. radiation workers) will be instructed by means of a documented training class in the risks of radiation exposure and the fundamentals of protection against exposure to uranium and its progeny. Other guidance to be provided as appropriate is found in NRC Regulatory Guide 8.13 *"Instruction Concerning Prenatal Radiation Exposure"* and NRC Regulatory Guide 8.29 *"Instruction Concerning Risks From Occupational Radiation Exposure"*. The course of instruction will include the following topics:

- Fundamentals of Health Protection
  - The radiological and toxicological hazards of exposure to uranium and its progeny
  - How uranium and its progeny enter the body (inhalation, ingestion, and skin penetration)
  - Why exposures to uranium and its progeny should be kept ALARA
- Personal Hygiene
  - Wearing protective clothing
  - Using respirators correctly
  - Eating, drinking, and smoking only in designated areas
  - Using proper methods for decontamination (for example, showers)

- Facility-Provided Protection
  - Ventilation systems and effluent controls
  - Cleanliness of the work place
  - Features designed for radiation safety for process equipment
  - SOPs
  - Security and access control to designated areas
  - Electronic data gathering and storage
  - Automated processes
- Health Protection Measurements
  - Measurement of airborne radioactive materials
  - Bioassays to detect uranium radionuclides
  - Surveys to detect contamination of personnel and equipment
  - Personnel dosimetry
- Radiation Protection Regulations
  - Regulatory authority of the NRC, Mine Safety and Health Administration (MSHA), and Occupational Health and Safety Administration (OSHA)
  - Rights of employees in 10 CFR Part 19
  - Requirements for radiation protection in 10 CFR Part 20
- Emergency/contingency Plans

A written or oral test with questions directly related to the training topics will be given to each worker. The instructor will review the test results and discuss incorrect answers with each worker. Workers who fail the test (less than 70 percent correct) will be retested after receiving additional training.

All new workers will be given specialized instruction on the health and radiation safety aspects of the specific jobs they will perform. This instruction will be in the form of individualized on-the-job training. Radiation safety matters of concern that arise during operations will be discussed with all workers during regularly scheduled safety meetings.

5.5.2 Refresher Training

Each radiation worker and supervisor will be provided annual refresher training. Refresher training will include relevant information that has become available during the past year, a review of safety problems that have arisen during the year, changes in regulations and license conditions, exposure trends, and other current topics.

5.5.3 Visitor Training

All visitors who enter process areas and have not received training described in Section 5.5.1 will be escorted by someone trained and knowledgeable about the hazards at the facility. At a minimum, visitors will be instructed specifically on what they should do to avoid possible hazards (radiological and nonradiological) in the areas of the facility they will be visiting.

5.5.4 Contractor Training

Contractors that have work assignments at the facility will be given appropriate training and safety instruction. Contract workers who will perform work on heavily contaminated equipment or within the process area shall receive the same training and radiation safety instruction normally required of all radiation workers. Only job-specific radiation safety instruction is necessary for contract workers who have previously received full training on prior work assignments at the facility or have documentation of recent and relevant radiation safety training elsewhere.

5.5.5 RSO Training

The RSO will receive a minimum of 40 hours of documented refresher training in health physics at least once every two years.

5.5.6 Training Documentation

All workers will be required to sign a statement that they have received radiation safety training. The statement will indicate the content of the training and the date(s) the training was received. The statement will be co-signed by the instructor. This documentation applies to initial and refresher training.

5.6 Facility Security

As required in 10 CFR 20, Subpart I, Powertech (USA) will secure from unauthorized removal or access licensed materials stored in controlled or unrestricted areas using the following passive and administrative controls:

- All areas where licensed material is stored (e.g. well fields, CPP, SFs will be fenced.
- All gates accessing areas where licensed material is stored will be posted as described in Section 5.2.4 and locked when facility personnel are not immediately available to prevent unauthorized access to or removal of licensed materials.
- Facility fences, gates, and postings will be inspected daily as part of the inspection programs described in 5.3.1 and 5.3.2.
- A 24-hour per day, 7 day per week staff will be on duty at the facility.
- Visitors to the facility will enter through an access point at the main plant entrance where they will sign in and receive training required in Section 5.5.3.

Powertech (USA) will control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and is not in storage. An example of licensed material not being in storage is licensed material being transported from the SF to the CPP. Passive and administrative controls to prevent unauthorized access to and removal of licensed material not in storage include:

- SOPs assessing the possible transportation security risks and identifying measures to mitigate these risks
- Locks and/or tamper indicators on all openings where licensed material is kept
- Off-site vehicles transferring licensed materials will always be secure if left unattended
- Off-site vehicles transferring licensed materials will be visible by an employee at all times when left unattended outside of a restricted area

The requirements of 49 CFR 172 will apply to shipments of licensed material which Powertech (USA) offers for transport for commercial use. Powertech (USA) will develop SOPs for these cases and will evaluate the ability of potential commercial contractors offering transportation services to comply with the requirements of 49 CFR 172 prior to entering into a contracting agreement.

5.7 Radiation Safety Controls and Monitoring

This section describes the active and passive effluent control techniques used to ensure that occupational and public doses of ionizing radiation will be ALARA. The monitoring program used to confirm that ALARA is attained is also described.

5.7.1 Effluent Control Techniques

The project will generate effluent typical of other ISL facilities. Both the Dewey site and the Burdock sites will include well field and IX operations with similar effluents and effluent control techniques. At the Burdock site, the CPP will also produce effluents typical from a yellowcake processing facility.

Airborne emissions of concern include the release or potential release of radon-222 and dried yellowcake dust. Liquid phase effluents consist of well field bleed streams that will contain both uranium and radium, as well as a liquid brine stream from the CPP. Solid wastes include contaminated equipment and protective clothing as well as solid residues from settling and evaporation ponds.

Monthly "grab" sampling of the treated wastewater streams generated at the facility, and stored in the respective storage reservoir, will be necessary to demonstrate that the barium chloride treatment systems are operating properly and treating radium-226 concentrations to maintain regulatory compliance.

5.7.1.1 Airborne Effluents

Under routine operation radon-222 would be the only effluent of concern from production and restoration solutions. The airborne particulate of most concern in an ISL facility is yellowcake dust. Yellowcake drying will be conducted in hot-oil rotary dryers operated under vacuum to prevent the release of uranium during drying. This method is described in Section 4.0; there are no emissions from vacuum dryer systems. Routine wash-down procedures will keep work areas clean of accumulating uranium as well as dirt and dust from outside sources. Yellowcake is only present as a dry solid from the end of the dryer cycle through packaging operations.

The process facility is designed such that the dryer and packaging operation are contained within a separate room, with its own HVAC system as well as a sealed hood system to prevent leakage of yellowcake solids during transfer from the dryer to the packaging drums. A dedicated air handler equipped with high efficiency particulate air (HEPA) filters will ventilate the dryer and packaging room and will provide an additional level of controlling particulate emissions.

To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signal an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is routinely monitored during dryer operations. The operator will perform and document inspections of the differential pressure or vacuum every four (4) hours. Additionally, the air pressure differential gauges for other emission control equipment is observed and documented at least once per shift during dryer operations.

The venting systems described above will be completely separate from the building heating, ventilating, and air conditioning (HVAC) system. The HVAC system will be on when the buildings are normally closed due to weather or other factors.

Pregnant lixiviant will come into the SF and some radon-222 will be present. The lixiviant will be directed to the down-flow IX vessels to separate out uranium.

At both the SF plants and the CPP, the air/vacuum relief valves on the IX columns will be piped together in a manifold which will be vented above the roofline of the building. In addition, a flexible duct designed to attach to tanker trucks during loading and unloading of resin will be connected to this vent manifold. Pressure transmitters and pressure gauges on the inlet and outlet piping connected to each vessel will measure and indicate pressure both locally and in the control room. This vent system will not have a fan because vacuum relief requires an inflow of air. This vacuum relief system will minimizes exposure to personnel.

Small amount of radon-222 may be encountered during a spill, filter changes, IX resin transfer operations and maintenance activities. Exhaust fans will be placed in key areas of the building to remove any radon that may be released inside the building. Based on similar facilities historical operational experience, personnel exposures are not expected to be significant.

To ensure airborne effluents are ALARA according to 10 CFR 20.1301, ventilation system verification will be performed. The verification procedure will also ensure effluent is within ALARA constraints established under 10 CFR 20.1101(d). NRC Regulatory guide 3.56 will be utilized for guidance as well. More detailed information on effluent controls are discussed in Sections 3.0 and 4.0 of this application. Inspections of radiation controls and equipment will be conducted during radiation safety inspections as discussed in Section 5.3.1.

5.7.1.2 Liquid Effluents

Liquid effluents consist of two types:

Liquid Process Waste

Liquid effluents from the operation will include: production bleed stream, as discussed in Section 3.0, excess brines from the elution and precipitation process, yellowcake rinse water, plant wash-down water, restoration bleed, analytical laboratory waste, and facility sanitary waste.

The net production bleed stream will flow at a rate of one half to three percent of the flow rate of production composite. Production bleed will be routed to either the wastewater disposal system or the production bleed RO unit. The restoration bleed stream will consist of 100 percent of the water removed during well field restoration. Both production composites removed during recovery and restoration bleed streams will first be treated in the IX columns to remove uranium to low levels. The streams are then treated to remove radium by the addition of a small amount of barium chloride and the settling out of the resultant barium-radium sulfate solids in a settling pond. After radium removal, the pond water will be pumped to land application sites where it will be utilized to irrigate agricultural crops.

Excess liquids from the Burdock CPP elution and precipitation circuit are expected to average about 12 gallons per minute and will be routed to a lined evaporation pond. After partial concentration of the solids through evaporation, this waste brine will be disposed of by trucking to a location in another state for injection into a licensed waste disposal well, or by continued evaporation to near dryness and subsequent disposal in an appropriate NRC licensed disposal facility. Less than 2 gallons per minute of water will result from plant wash water. This water will be commingled with other plant wastewater or may be used as process make-up water if it is of satisfactory quality.

Aquifer Restoration

Two techniques for groundwater restoration are proposed:

- Groundwater Treatment
- Well field Circulation

Groundwater treatment involves the use of process equipment to lower ion concentration of the water in the production zone. Brine water is produced during this activity and is disposed of via waste disposal well. Chemical reducing agents may also be employed during this phase of treatment.

Facility sanitary waste will be relatively small in quantity and will be treated in an appropriately sized septic system with sanitary drain field.

5.7.1.3 Spill Provision Plans

Procedures to address potential spills will be the responsibility of the radiation safety department; engineers and operations supervisors will assist in development of procedures. The SERP will review the procedure for effectiveness. Procedures developed will implement appropriate protocol to handle potential spills of radioactive materials. Nine responsibilities comprise basic activities:

- Resources and manpower assigned.
- Material and Inventory.
- Identification of potential spill sources.
- Spill reporting and visual inspection program established.
- Review of past spill incidents.
- Coordination among all departments for containment of spills.
- Emergency response protocol established.
- Program implementation, review and updating.
- New construction and changes in process relative to prevention and control of spills will be reviewed.

There are two types of spills that may result from an in situ operation:

Surface Releases

Potential surface releases may be the result of a tank failure, ruptured pipe, or transportation incident.

Failure of a process vessel will be contained within the CPP via berms and directed into a sump (equipped with a level alarm) that will allow the solution to be transported to appropriate tank or disposal system.

Piping system leaks is the most common source of surface releases that occur at an in situ facility. Generally these spills are small due to engineering controls set up to detect changes in pressure within the piping systems. Operators are alerted via an alarm system when pressure changes occur. Well field piping systems are constructed of PVC or high density polyethylene (HDPE) materials with butt welded joints or the equivalent. All pipelines will be pressure tested at operating pressures before put online. No additional stress is placed on the buried pipes so it is improbable a break would occur. The underground portions of the pipes are protected from vehicles and exposed pipes only occur at the wellheads and header houses. Trunkline flows and wellhead pressures will be monitored for process control. Spill response is specifically addressed in the Emergency Response Procedures (Energy Metals Corporation, U.S, 2007).

Spills related to transportation will be addressed in Powertech's (USA) Emergency Response Action Plan. Specific actions involving response to a radioactive materials shipment will include instructions for appropriate packaging, documentation, driver emergency and accident response procedures and cleanup and recovery protocol.

Subsurface Releases

Potential subsurface releases such as a well excursion may result in the migration of process fluids.

Monitoring wells will be set up around the well field for detection of any leach fluids that may potentially migrate away from the production zone due to an imbalance in well field pressure. The monitoring well detection system is a proven method historically among ISL operations. Powertech (USA) proposes to locate a ring of monitoring wells no farther than 400 feet from the well field. These monitoring wells will be screened in the same zone as the production well. There will be additional wells monitoring the aquifers above and potentially below the ore-bearing aquifer. Sampling of monitoring wells will occur on a weekly or bi-weekly basis. Recovery and monitoring work in conjunction, as a coordinated effluent control system, and has proven effective in early detection of recovery fluids for a number of reasons:

- Close proximity of monitoring wells to well field

- Low flow of production wells
- Cone of depression created from production bleed

The overall effect of the system makes non-detection highly unlikely.

Effluent controls for preventing migration of recovery solutions to overlying and underlying aquifers consist of:

- Plugging and Abandonment of all exploration holes.
- Conducting Mechanical Integrity Tests (MITs) on each well before it is put on line.
- Sampling the monitoring wells located within the overlying and underlying aquifers on a frequent schedule.

These controls work together to prevent and detect production fluid migration. Plugging exploration holes prevents connection of the ore-bearing aquifer to overlying and underlying aquifers. The EPA UIC requirement of MITs assures proper well construction and is the first line of defense for maintaining appropriate pressure without leakage. Sampling the monitor wells will enable early detection of any production solutions should an excursion occur.

Sediment or erosion of existing soils has the potential to lead to a release of undesirable elements in addition to the aforementioned spills. The greatest likely hood of this type of release may occur during the construction phase of the project. Two types of Best Management Practices (BMPs) will be employed to minimize the effects of runoff during precipitation events. One type is erosion prevention practices and the second type is sediment control practices.

Erosion Prevention Practices utilize ground covers that prevent different types of erosion from occurring. Ground covers include but are not limited to:

- Vegetation
- Riprap
- Mulch
- Blankets

Sediment control practices prevent soil particles that are being carried in storm water from leaving the site. These types of controls may consist of:

- Silt fence
- Sediment traps
- Sediment basins
- Vegetative cover

Leaving as much of the vegetation in place for as much of the construction period as possible will reduce the potential for a precipitation event to cause significant erosion and soil loss on-site. Utilizing erosion prevention and sediment controls in combination will prevent sediment loss during a major precipitation event. In addition to the above mentioned controls, engineering design and administrative controls will also minimize and control erosion and runoff. Should a pipeline failure coincide with a precipitation event, there is potential for a release. Relative soil saturation beneath the leak area would be a determining factor to what extent the material would be able to be absorbed. In any event with rapid detection and quick spill response a pipeline failure and migration of solutions due to runoff would be minimal.

5.7.1.4 Contaminated Equipment

Solid wastes generated by this project that are contaminated with process related material consist of materials such as rags, contaminated personal protective equipment, trash, packing material, worn or replaced parts from equipment, piping, sediments removed from process pumps and vessels . Radioactive solid waste that has a contamination level requiring controlled disposal will be isolated in drums or other suitable containers and disposed in a NRC licensed facility or as otherwise approved by the NRC. The combined operations at the SF and CPP will generate between approximately 100 to 300 yd^3 of radioactive contaminated waste each year. During final decommissioning of the CPP facilities and SFs, the volume of solid waste will increase. During final decommissioning of the CPP facilities and SFs, the volume will increase.

5.7.2 External Radiation Monitoring Program

Powertech (USA) will monitor external radiation exposure at the Dewey-Burdock facility. The monitoring will be done in three ways: continuous measurements at fixed locations, employee monitoring, and period work area surveys. The external radiation monitoring program will be consistent with the recommendation contained in NRC Regulatory Guide 8.30 *"Health Physics Surveys in Uranium Recovery Facilities."*

5.7.2.1 Fixed Location Monitoring

External radiation exposure measurements will be made in the locations shown in Figures 5.7-1. The measurements will be made by standard industry thermo luminescent dosimeters (TLDs) or equivalent dosimeters and exchanged on a quarterly basis.

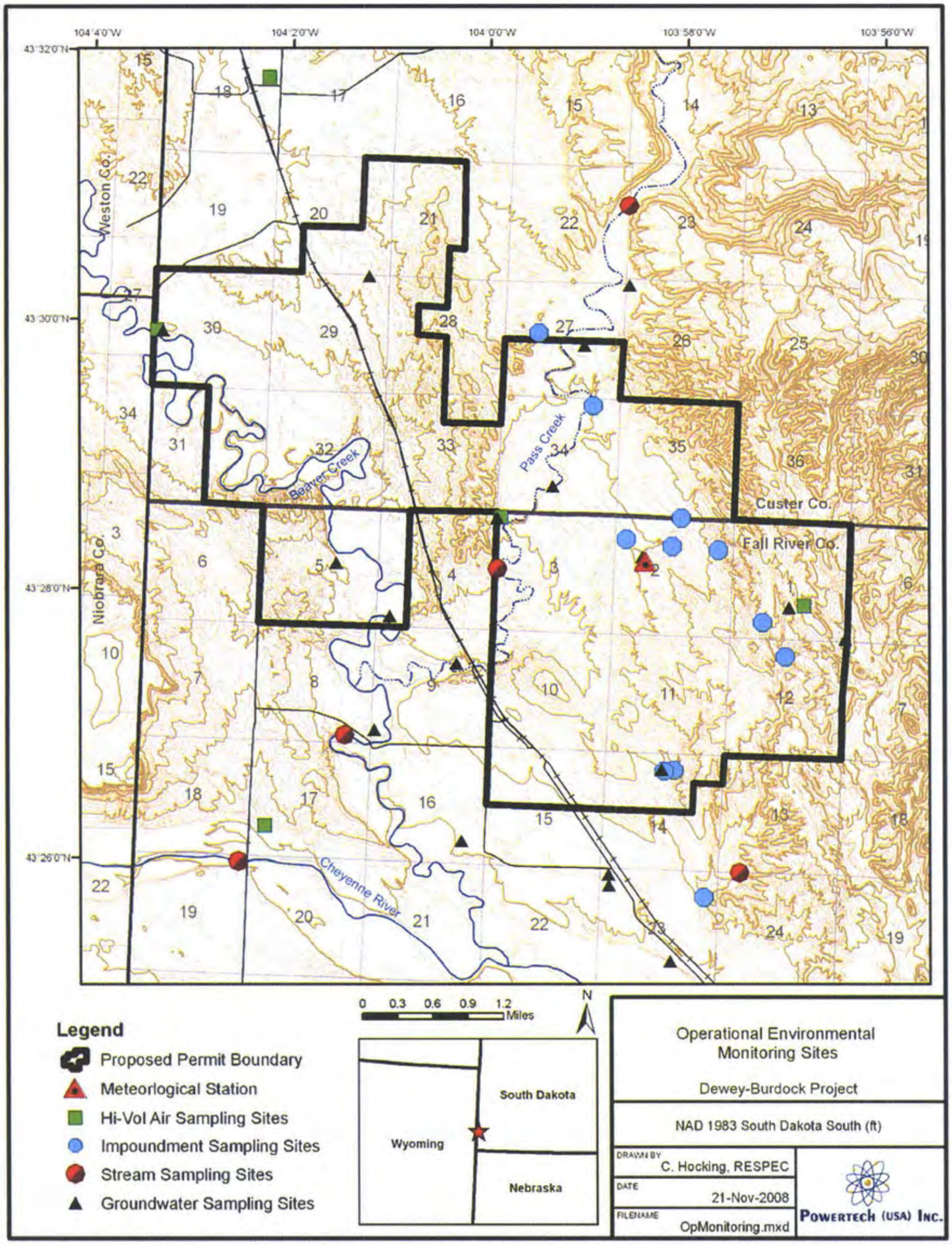

Figure 5.7-1: Proposed Operational Environmental Monitoring Sites

5.7.2.2 Employee Monitoring

Pursuant to 10 CFR 20.1502, employees working at the facility will be monitored for external radiation exposure if they have the potential to receive 10 percent of an applicable limit in a year. Monitoring requirements will be determined in accordance with guidance found in NRC Regulatory Guide 8.34.

The applicable adult worker radiation dose limits are as follows:

- 5 rem deep-dose equivalent (DDE)
- 15 rems lens dose equivalent (LDE)
- 50 rems shallow-dose equivalent to the skin (SDE)
- 50 rems shallow-dose equivalent to any extremity

Applicable limits for minors working at the facility are 10 percent of the adult limits listed above.

Applicable limits for declared pregnant workers are the same as adult workers with the exception of the DDE with is 10 percent of the adult limit for the period of gestation.

Employees not monitored that have a change in exposure potential such that they may receive 10 percent of an applicable dose listed above in one year will be monitored. Conversely, monitored employees can be eliminated from the external radiation monitoring program provided they no longer have the potential to receive 10 percent of the applicable doses listed above in one year.

Personnel monitoring for external radiation will be done by issuing dosimeters to personnel that require it. If needed, multiple dosimeters may be issued to employees that have the potential to receive two or more of the doses listed above. The dosimeters will have a sensitivity of 1 mrem and will be issued by a company currently holding personal dosimeter accreditation by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The dosimeters will be exchanged monthly for worker with declared pregnancies and quarterly for all other radiation workers.

All external doses received by monitored personnel above 10 percent of the above limits will be reported on NRC Form 5 or in a format which contains all the information listed on NRC Form 5.

5.7.2.3 External Radiation Surveys

Shortly after the facility becomes operational, at least 20 gamma radiation measurements will be taken in order to characterize the radiation levels at the facility, as stated in RG 8.30. The locations where these measurements will be performed are depicted on Figures 5.7-2 through 5.7-5. Based on these measurements, areas where a person may receive a dose of 5 mrem in 1 hour at 30 cm (1 foot) from a radiation source or radiation-emitting surface will be posted as a "Radiation Area" as required in 10 CFR 20.1902(a). For areas with radiation levels less than those defined for a radiation area, follow-up measurements will be performed semiannually to evaluate potential impacts of changing process conditions on facility radiation levels.

Areas posted as "radiation areas" will be investigated to determine the source of radiation and will be surveyed for gamma radiation on a quarterly basis as described in RG 8.30. Methods to reduce radiation levels using engineering controls, process adjustments, or maintenance practices will be evaluated once the source of radiation is determined

The instrumentation used in the external gamma radiation surveys will be portable, battery operated and will have a sensitivity of at least 0.1 milliroentgens per hour (mR/hr) and be able to measure radiation levels as high as 5 mR/hr.

The instrumentation will be calibrated according to the manufacturer's instructions or at least once a year. Operational checks on the instruments will be performed before each daily use. The instruments will be operated according to manufacturer's recommendation.

Since yellowcake will be generated at the facility, there is a potential hazard from external beta radiation. Specifically, operations requiring direct handling of aged yellowcake may lead to significant exposures to the skin. Therefore, a beta survey will be conducted at or near surfaces for each operation requiring direct handling of yellowcake. A beta survey will also be conducted when the equipment or operating procedures are changed in a way that may affect the exposure of the worker to beta radiation. These surveys will also be used in determining the level of personal protective equipment (PPE) required for the operations.

The instrumentation to be used in the beta surveys will be portable, have a sufficient efficiency for detecting beta radiation, and have a low efficiency for detecting gamma radiation. An example is a Ludlum Model 44-9 Pancake G-M Detector coupled with an appropriate ratemeter/scaler.

Beta doses will be determined using one of two ways. One method uses the information acquired during the beta radiation surveys. Average beta radiation fluence rates can be estimated, assuming all net counts are beta radiation from the yellowcake. The estimated average particle fluence rates, along with the amount of time spent on each operation by each worker and the average energy of beta radiation emitted from yellowcake can be used to determine the amount of radiation dose to the skin of the workers from beta radiation. The other method to determine beta radiation doses involve using Figures 1 and 2 from RG 8.30.

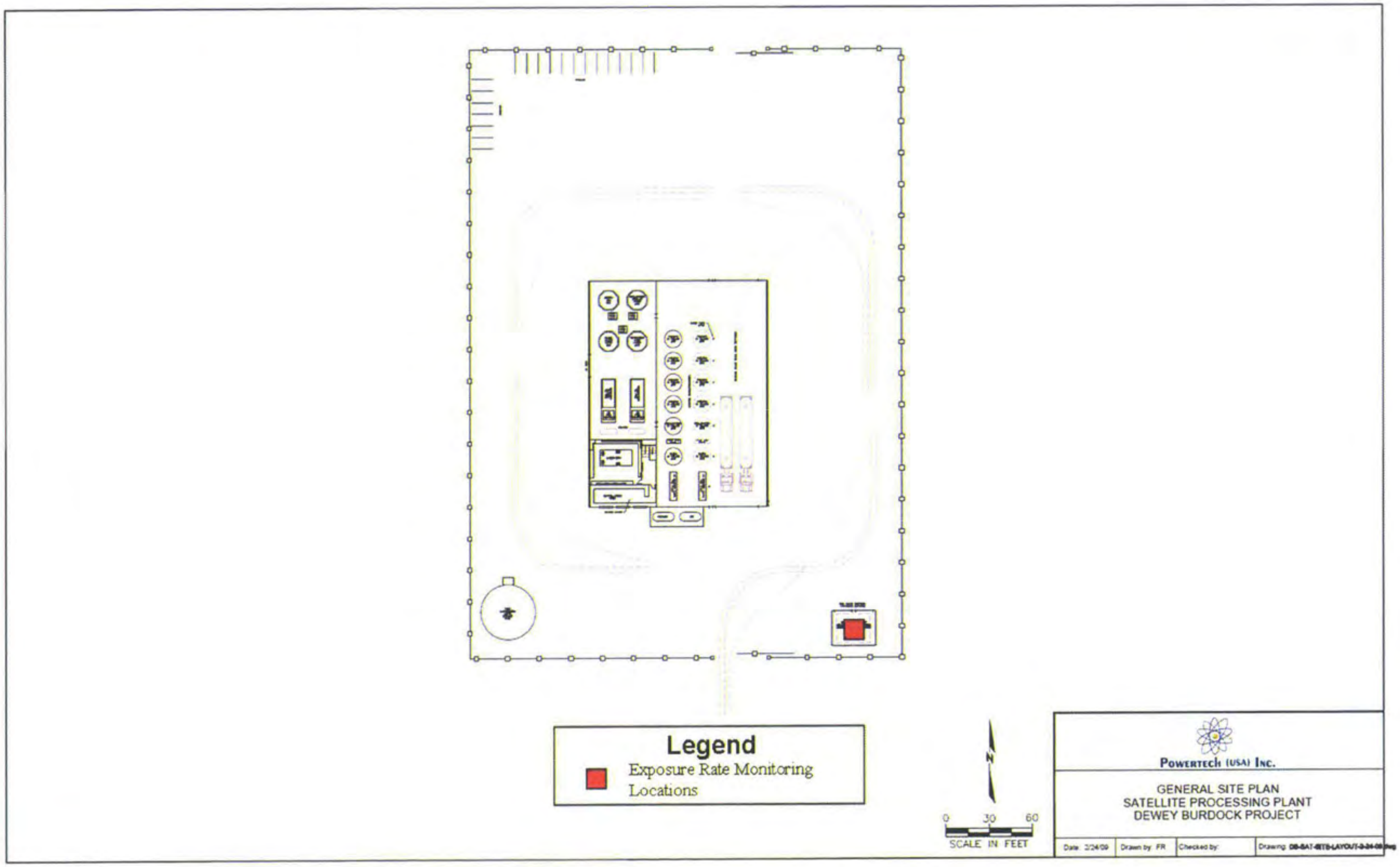

Figure 5.7-2: Locations of Exposure Rate Monitors on-site of Satellite Facility, Outside the Satellite Facility

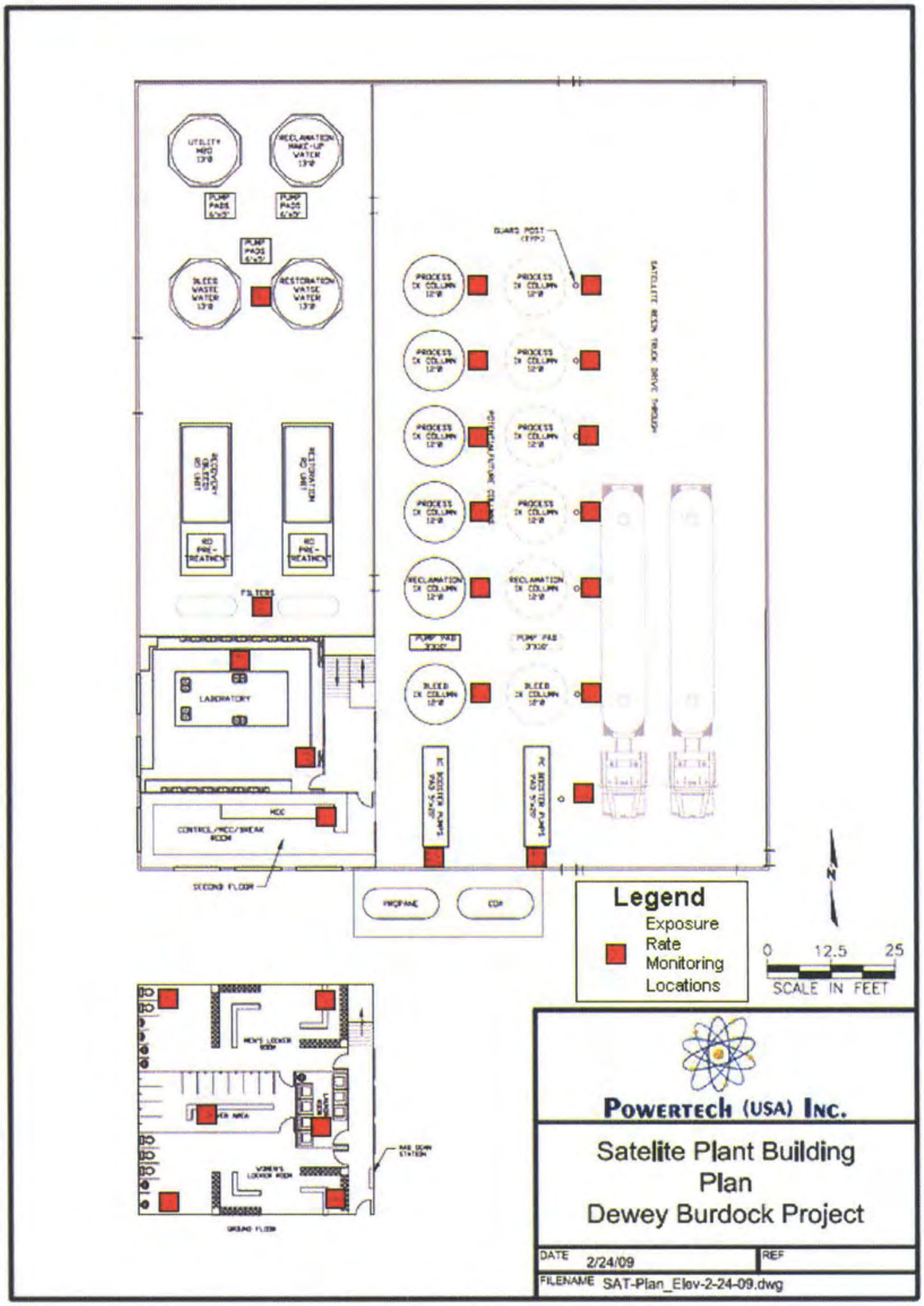

Figure 5.7-3: Locations of Exposure Rate Monitors Inside Satellite Facility

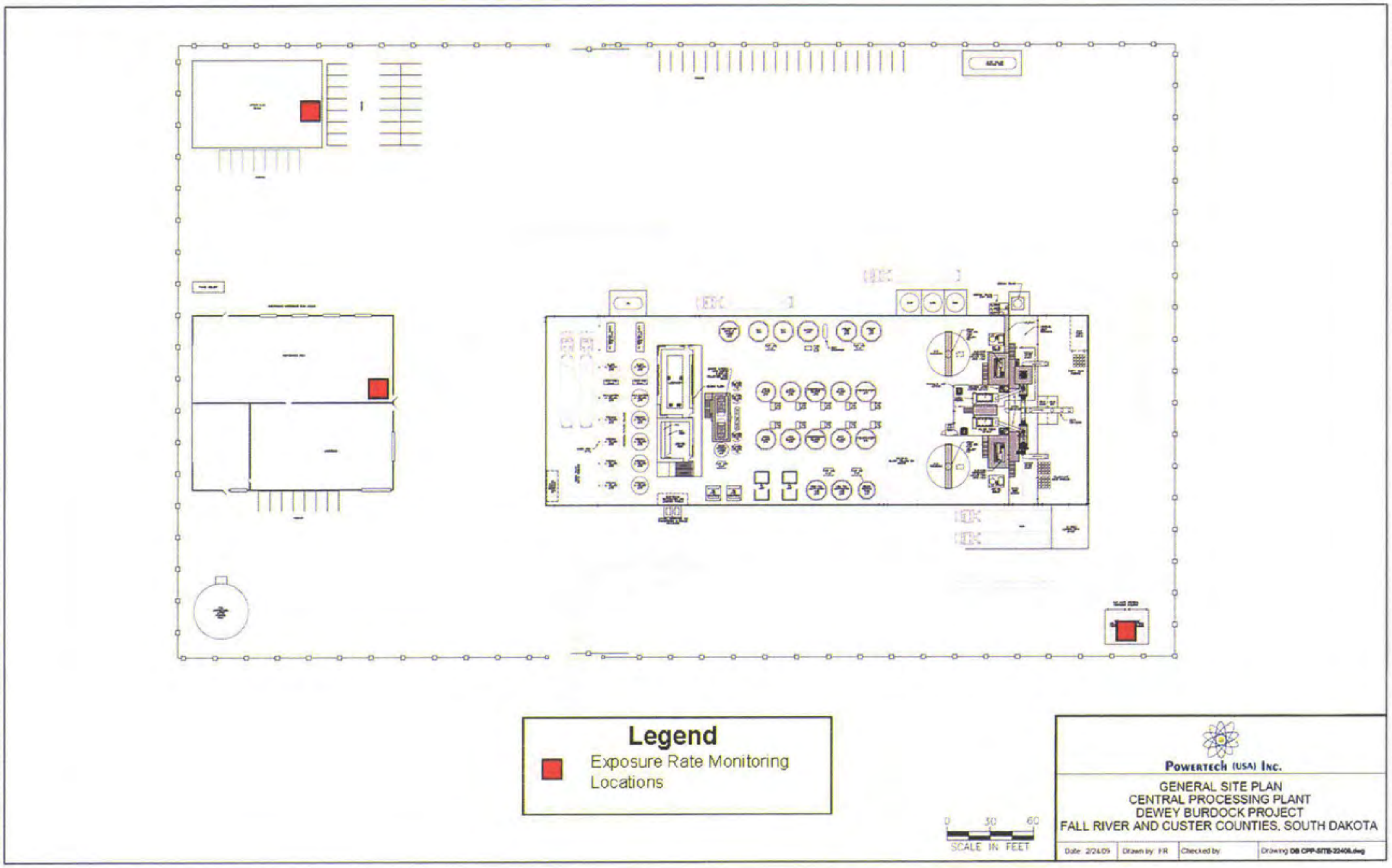

Figure 5.7-4: Locations of Exposure Rate Monitors on-site of Central Processing Plant, Outside the Central Processing Plant

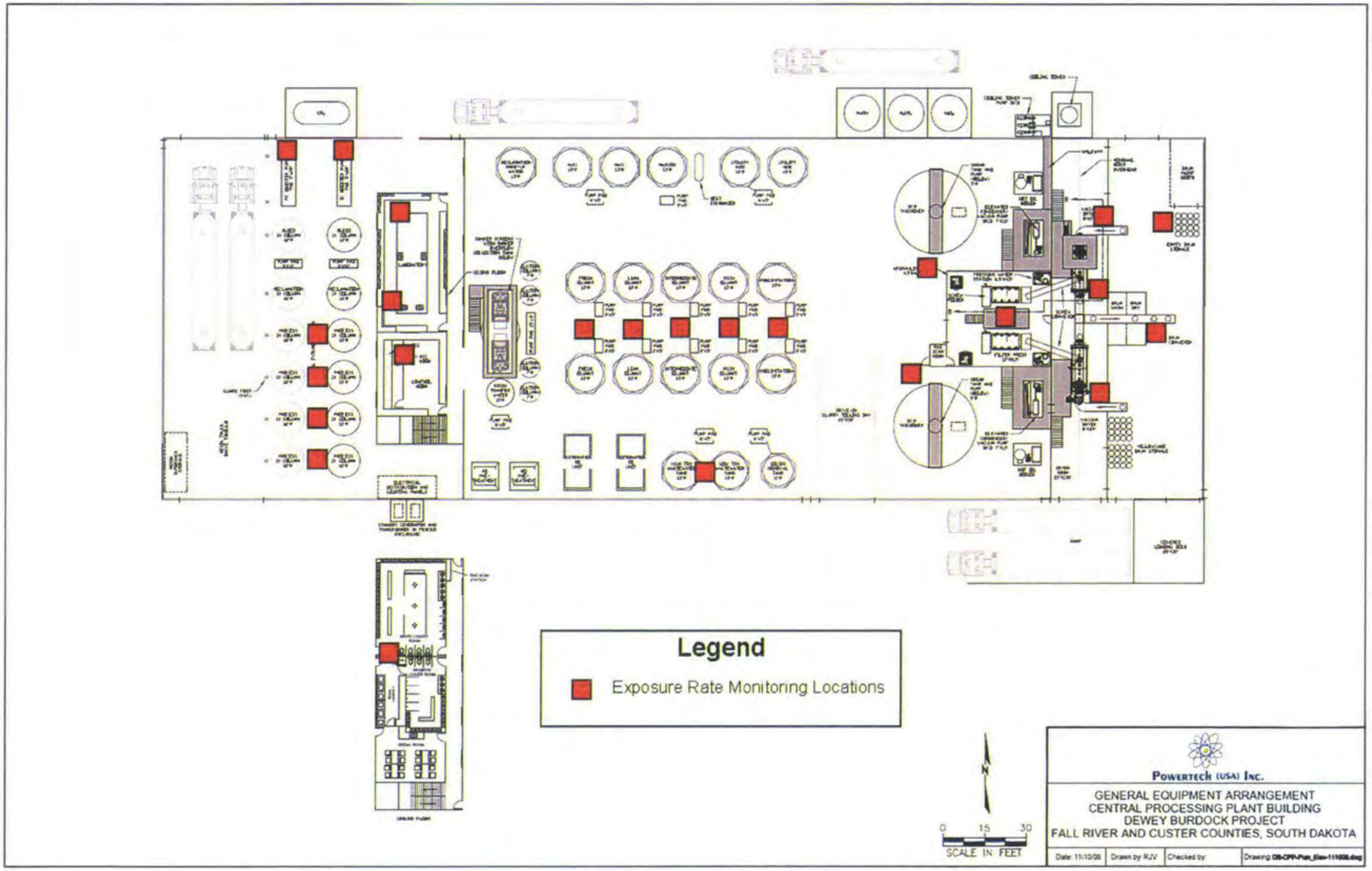

Figure 5.7-5: Locations of Exposure Rate Monitors in Central Processing Plant

5.7.3 Airborne Radiation Monitoring Program

Powertech (USA) will conduct an airborne radiation monitoring program at the project facility which is consistent with the recommendations contained in RG 8.30. The facility will not process ore. However, the facility will precipitate, dry (at low temperatures), and package yellowcake. Therefore, the monitoring program will consist of monitoring radon decay products, as well as airborne particulate monitoring.

5.7.3.1 Monitoring of Radon and Radon Decay Products

According to RG 8.30, measurements of radon decay products are a better measure for worker dose than measurements of radon. Therefore, measurements of radon decay products will be made in the facility.

Working level (WL) measurements for radon decay products will be made on a monthly basis in areas where radon decay product concentrations are likely to exceed 0.03 WL as described in RG 8.30. Figures 5.7-6 to 5.7-9 present the monitoring locations where radon decay products are most likely to exceed 0.03 WL. Additionally, areas where the radon decay product concentration exceeds 0.08 WL, as indicated by the monthly WL measurements, will be measured for radon decay products on a weekly basis. For these areas, investigations will be conducted to determine the source and corrective action will be taken if determined necessary by the RSO. If four consecutive weekly measurements in an area show the concentration of radon daughters to be at or below 0.08 WL, then the frequency of measurements in that area will return to monthly. Areas proximal to radon sources that do not exhibit radon decay product concentrations above 0.03 WL, as indicated by monthly WL measurements, will have WL measurement frequency reduced to quarterly. The time, date, and state of operation of the equipment in the vicinity of the measurement will be recorded.

The measurements will be performed by collecting samples on filter paper with a low-volume air sampler and analyzing the filter paper with an alpha counter using the Modified Kusnetz method described in ANSI N13.8-1973 or an equivalent method. The air sampler and alpha counter will be calibrated at the manufacturers' suggest time interval.

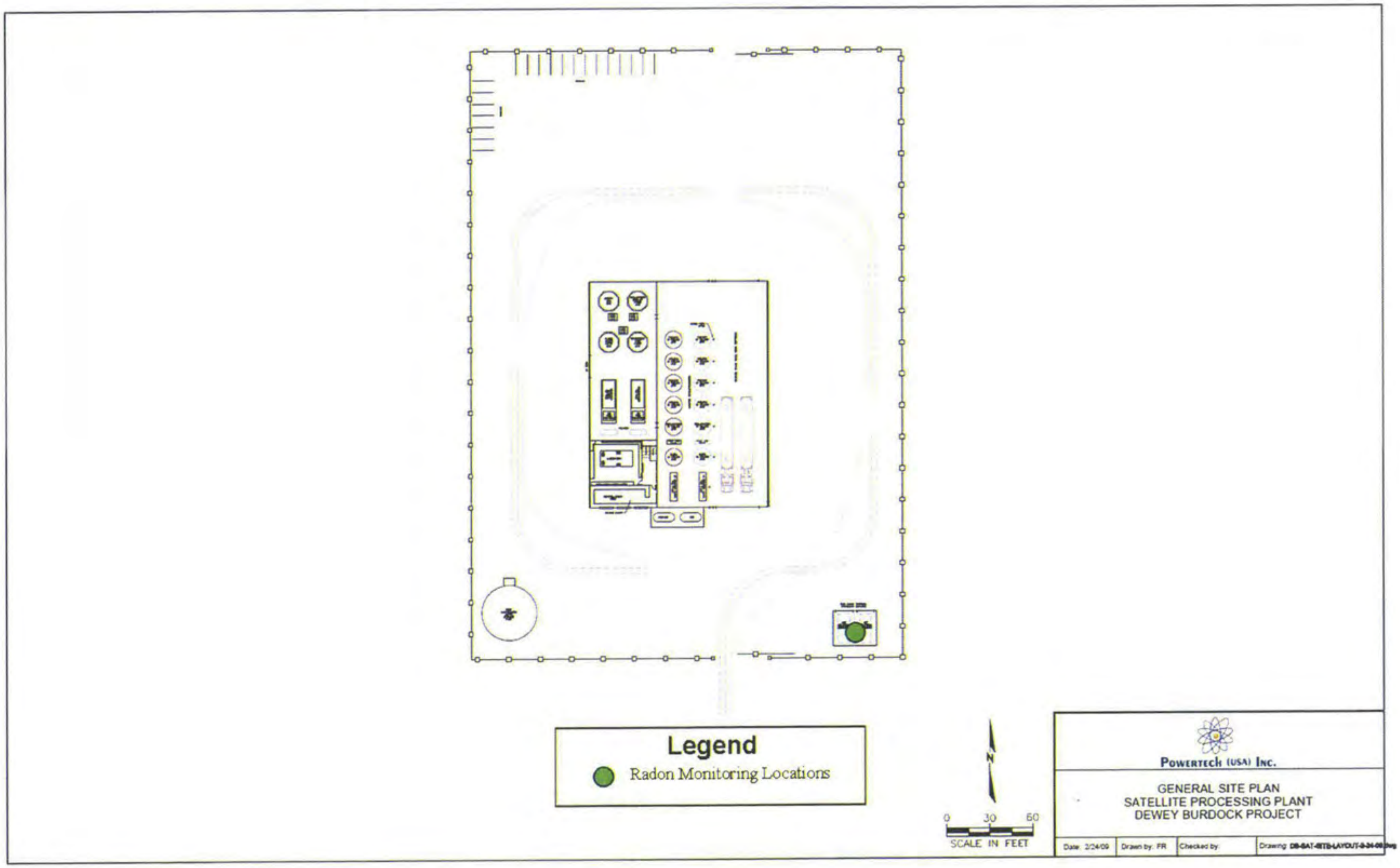

Figure 5.7-6: Locations of Radon Decay Product (Radon) Monitors on-site of Satellite Facility, Outside the Satellite Facility

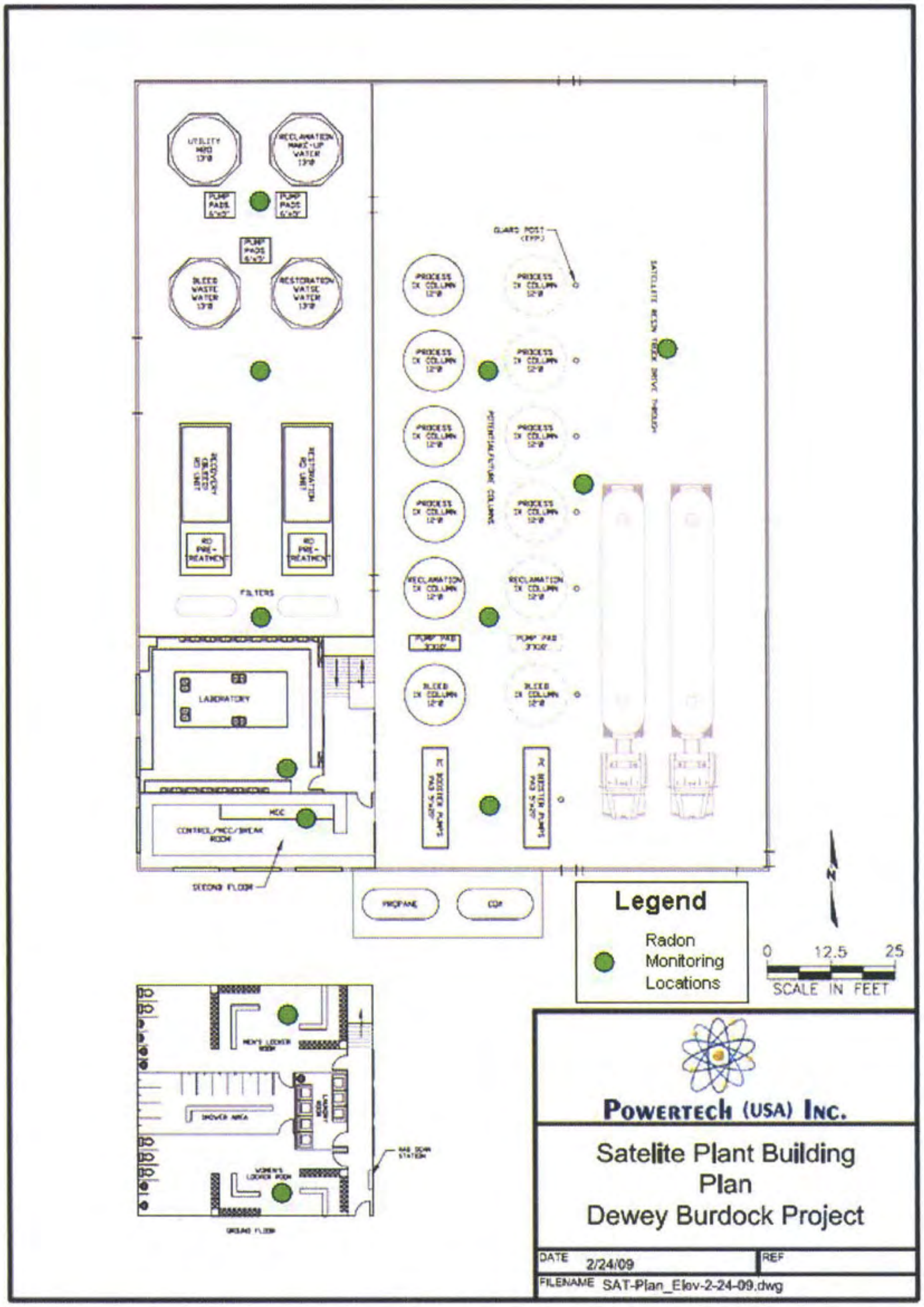

Figure 5.7-7: Locations of Radon Decay Product (Radon) Monitors in Satellite Facility

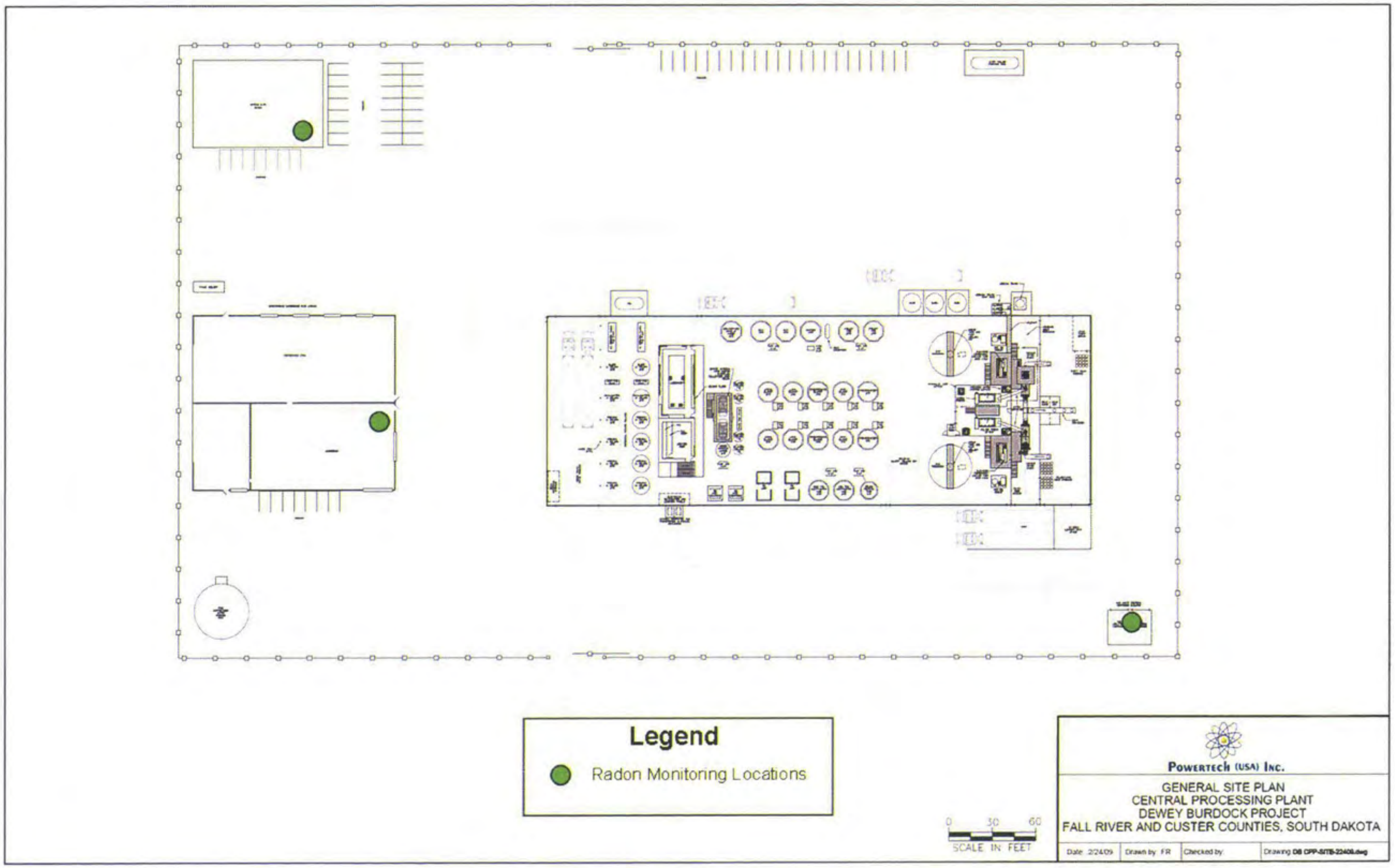

Figure 5.7-8: Locations of Radon Decay Product (Radon) Monitors on-site of Central Processing Facility, Outside the Central Processing Facility

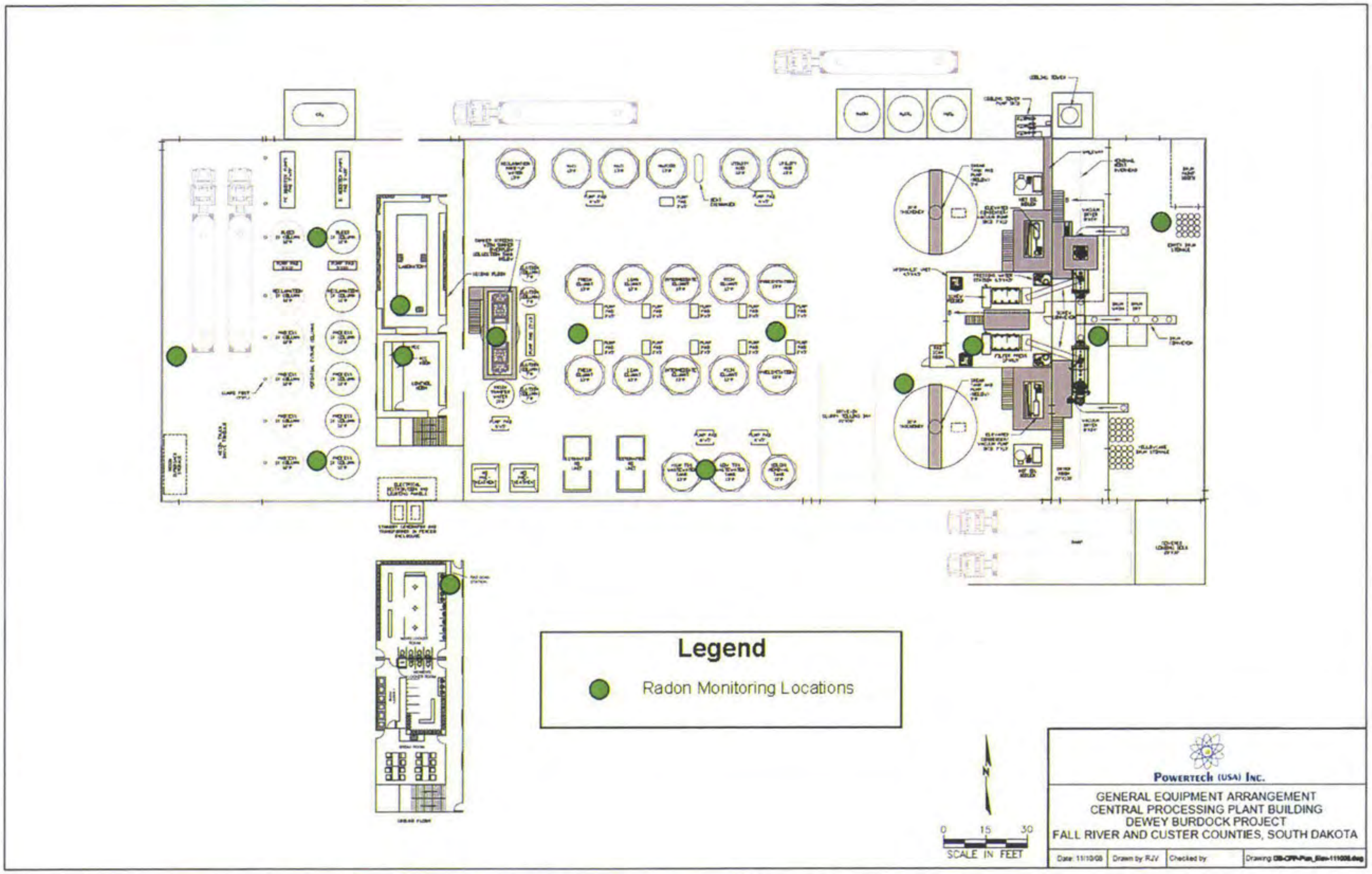

Figure 5.7-9: Locations of Radon Decay Product (Radon) Monitors in Central Processing Facility

5.7.3.2 Airborne Particulate Monitoring

Since there will be no ore grinding at the facility, no monitoring of airborne uranium ore dust will be necessary. However, airborne yellowcake will be monitored at the facility. The facility will be drying yellowcake under low temperature (approximately 450°F). No stack monitoring will be required for this proposed action. According to the footnotes of 10 CFR 20 Appendix B, yellowcake dried under low temperature should be considered soluble.

The limiting factor for health considerations for soluble uranium is chemical toxicity and not radiation dose. According to the footnotes for the radionuclide tables in 10 CFR Part 20 Appendix B, "the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed 8E-3 (SA) μCi-hr/ml, where SA is the specific activity of the uranium inhaled." Also in the foot notes, the specific activity for natural uranium is 6.77E-7 Ci/g.

When the limit in the footnotes is divided by 40 hours and the specific activity of natural uranium is taken into account, the 40-hr time-weighted average uranium concentration limit is 1×10^{-10} μCi / mL. This limit is consistent with the soluble uranium intake limit of 10 mg/week specified in 10 CFR 20.1201.2(e).

Areas meeting one of two criteria will be designated as airborne radioactivity areas. The first criterion is airborne yellowcake concentrations greater than 1×10^{-10} μCi / mL. The second criterion is potential for personnel to be exposed to 25 percent of that concentration, averaged over the number of hours exposed in a week (as recommended in RG 8.30).

In lieu of weekly 30 minute grab samples specified in RG 8.30, weekly low volume breathing zone samples will be taken from representative workers in airborne radioactivity areas. Breathing zone samples provide a better estimate of airborne particulate concentrations to which workers are exposed, resulting in a more representative estimate of actual intakes. The sensitivity of this method shall be at least 1×10^{-11} μCi / mL.

Breathing zone samples will be taken during non-routine operations with potential for a worker to receive exposure to airborne yellowcake above 1×10^{-10} μCi / mL. The monitoring type and frequency for non-routine tasks will be described in the job-specific RWP as described in Section 5.2.2

All air samples will be analyzed for uranium within two working days after sample collection. The lower limit of detection (LLD) of all analyses of air samples will be no greater than 1 x 10^{-11} µCi / mL. The calculation of LLDs for measuring concentration of uranium in air is derived from the method to calculate minimum detectable activity (MDA) shown in NRC Regulatory Guide 8.25 "*Air Sampling in the Workplace*".

The calculation of MDAs is shown in Equation 5.1.

$$MDA = \frac{2.71 + 3.29[R_b T_s (1 + T_s/T_b)]^{1/2}}{EKT_s} \qquad \text{Equation 5.1}$$

Where R_b is the background count rate (counts per minute), T_s is the counting time of the sample (minutes), T_b is the counting time of background (minutes), E is the filter efficiency, and K is the calibration factor to convert activity into count rate (counts per minute per microcurie). Therefore, the units of the calculated MDAs are microcuries. In order to yield LLD, the MDA will be divided by the volume of air sampled as shown in Equation 5.2.

$$LLD = \frac{2.71 + 3.29[R_b T_s (1 + T_s/T_b)]^{1/2}}{VEKT_s} \qquad \text{Equation 5.2}$$

Where V is the volume of air sampled (milliliters).

5.7.3.3 Respiratory Protection

The respiratory protection program at the facility will be conducted in accordance with NRC Regulatory Guide 8.15 "*Acceptable Programs for Respiratory Protection*" and NRC Regulatory Guide 8.31 "*Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable*", Section 2.7 and 10 CFR 20 subpart H.

5.7.4 Exposure Calculations

In accordance with 10 CFR 20.1202, the total effective dose equivalent for all radiation workers will be determined by summing the DDE from external radiation and the committed effective dose equivalent (CEDE) from internal radiation.

5.7.4.1 Internal Exposure

CEDEs due to inhalation of yellowcake will be determined by either using the stochastic annual limits of intake (ALIs) listed in Table 1 of 10 CFR 20 or using the derived air concentrations (DACs) listed in the same table.

The calculation of the committed effective dose equivalents, using either method, will be performed according with RG 8.30, Section C. These calculations will also be supported by the facility's bioassay program described in Section 5.7.5.

5.7.4.2 Radon Decay Production Exposure

The amount of radon decay products exposure an employee received in a year will be calculated using the following equation:

$$E_{rd} = \frac{1}{170}\sum_{i=1}^{n}\frac{C_i \times t_i}{PF_i} \qquad \text{Equation 5.3}$$

where E_{rd} is the exposure to radon decay products in working level months (WLM) the employee received in a year, C_i is the average concentration, or working level (WL), of radon decay products of each exposure, t_i is the time of each exposure in hours, PF_i is the respiratory protection factor of each exposure, and n is the number of exposures the employee had during the year.

According to 10 CFR 20 Appendix B, 4 WLM equates to 5 rem CEDE.

5.7.4.3 Prenatal and Fetal Exposure

The dose to the embryo and fetus is calculated as the sum of the deep-dose equivalent of the declared pregnant worker and the dose to the embryo/fetus from radionuclides in the embryo/fetus and the declared pregnant worker. The calculations will be done according the NRC Regulatory Guide 8.36 *"Radiation Dose to the Embryo/Fetus"*.

5.7.5 Bioassay Program

A urinalysis bioassay program will be established at the facility in order to detect employee intakes of uranium. The program will be consistent with the recommendations contained in NRC Regulatory Guide 8.22 "*Bioassays at Uranium Mills*" (RG 8.22). All employees that will handle yellowcake will give a urine sample prior to starting employment and upon termination of employment. During operation of the facility, each employee that has the potential to ingest or inhale yellowcake will give a urine sample on a monthly basis.

Additionally, urine samples will be collected from workers who were exposed to airborne yellowcake suspected of exceeding the 40-hr weekly limit of 1×10^{-10} µCi / mL.

All urine samples will be analyzed for uranium content by a contract laboratory that can achieve a minimum sensitivity of 5 µg/L. The results of the analyses will be documented. Action levels for urinalysis will be established based upon Table 1 in RG 8.22.

5.7.6 Contamination Control Program

Powertech (USA) will conduct a contamination control program at the project facilities consistent with recommendations contained in RG 8.30. The purpose of the program is to prevent contamination from spreading to unrestricted areas and needlessly exposing people to radiation. The program will address potential contamination spreading from areas where uranium work is performed, from personnel working in those areas, and from equipment and respirators used in those areas. The program will also address the survey equipment used to locate contamination. The ALARA goal for contamination control is to reduce the residual contamination on personnel and equipment to be released from the controlled area to as low as reasonably achievable.

5.7.6.1 Areas

Areas where uranium work is performed with surface contamination above 5,000 dpm alpha per 100 cm^2 (averaged over no more than 1 m^2), spots of contamination above 15,000 dpm alpha per 100 cm^2 (averaged over no more than 100 cm^2), or removable contamination above 1,000 dpm alpha per 100 cm^2 will be restricted.

To meet the ALARA concept, surfaces in restricted areas exposed to the air will be limited to having surface contamination of 220,000 dpm alpha per 100 cm^2.

Unrestricted areas will be spot checked weekly for removable surface contamination. If a spot check finds an area of removable surface contamination above background in an unrestricted area, that area will be cleaned and resurveyed for removable surface contamination.

5.7.6.2 Personnel

Personnel working in restricted areas as described in Section 5.7.6.1 will wear protective clothing to mitigate the potential for skin contamination.

Personnel exiting restricted areas with removable surface contamination will self survey for surface contamination in order to prevent the spread of contamination to unrestricted areas. Areas of skin measured to be above background will be washed until they no longer read above background. Clothing measured to have alpha contamination above background will be laundered or properly disposed. Soles of shoes reading higher than background alpha levels will be washed and scrubbed until they are no longer above that value. Each survey of personnel leaving a restricted area and the subsequent decontamination will be documented.

Additionally, random surveys of personnel by a member of the radiation protection staff will be conducted quarterly to ensure that the contamination control program is performing adequately.

5.7.6.3 Equipment

Equipment leaving restricted areas with removable contamination will undergo decontamination followed by a survey for removable contamination in order to prevent the spread of contamination to unrestricted areas. The surveys will be for alpha radiation and beta-gamma radiation. Equipment found to have average radiation levels at or below 5,000 dpm alpha (or beta-gamma) per 100 cm^2 (averaged over no more than 1 m^2), removable contamination at or below 1,000 dpm alpha (or beta-gamma) per 100 cm^2, and spots (areas 100 cm^2 or smaller) at or below 15,000 dpm alpha (or beta-gamma) per 100 cm^2 will be cleared for unrestricted use. Equipment that exceeds the contamination limits will undergo further decontamination until the contamination is below the limits or until decontamination yields no reduction in contamination. Equipment with contamination above any of the limits after attempts of decontamination will be properly disposed. Each survey of equipment leaving a restricted area and the subsequent decontamination will be documented.

5.7.6.4 Respirators

Respirator hoods and face pieces will be surveyed for removable surface contamination before each reuse. Any pieces that have removable surface contamination above background will be decontaminated or replaced. Each survey of respirator hoods and face pieces and the subsequent replacement will be documented.

5.7.6.5 Survey Instrumentation

For tests of removable alpha contamination, swipes or wipes will be used and then counted with an alpha detector designed for sample counting. The same method will be used for testing for removable beta-gamma radiation except the counting will be done with a beta-gamma detector designed for sample counting.

For other measurements for surface contamination, a battery-operated portable alpha detector will be used to directly measure the surface for alpha contamination and a battery-operated portable beta-gamma detector will be used to directly measure the surface for beta-gamma contamination.

In each scenario, the alpha detector used will be able to detect alpha radiation ranging from 100 to 220,000 dpm per 100 cm^2 and the beta-gamma detector used will be able to detect beta-gamma radiation ranging from 1,000 to 15,000 dpm per 100 cm^2.

The instrumentation will be calibrated according to the manufacturer's specifications annually or at the manufacturer's recommended interval, whichever is more frequent.

5.7.7 Airborne Effluent and Environmental Monitoring Program

Powertech (USA) will conduct an airborne effluent and environmental monitoring program during operations consistent with recommendations in NRC Regulatory Guide 4.14 "*Radiological Effluent and Environmental Monitoring at Uranium Mills*" (RG 4.14). The program will consist of sampling air, water, vegetation, livestock, and surface soil.

5.7.7.1 Air Monitoring

Locations of air monitoring stations are shown in Figure 5.7-10. The filters from air samplers operating continuously will be analyzed quarterly for natural uranium, thorium-230, radium-226, and lead-210. Samplers will have sensors to measure total air flow within a sampling period. Passive track-etch detectors will be deployed at each station for monitoring radon-222 on a quarterly basis. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14.

Additionally, effluents from the yellowcake dryer and packaging stacks will be sampled quarterly. The grab samples will be isokinetic in nature and will be analyzed for natural uranium, thorium-230, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with recommendations of RG 4.14.

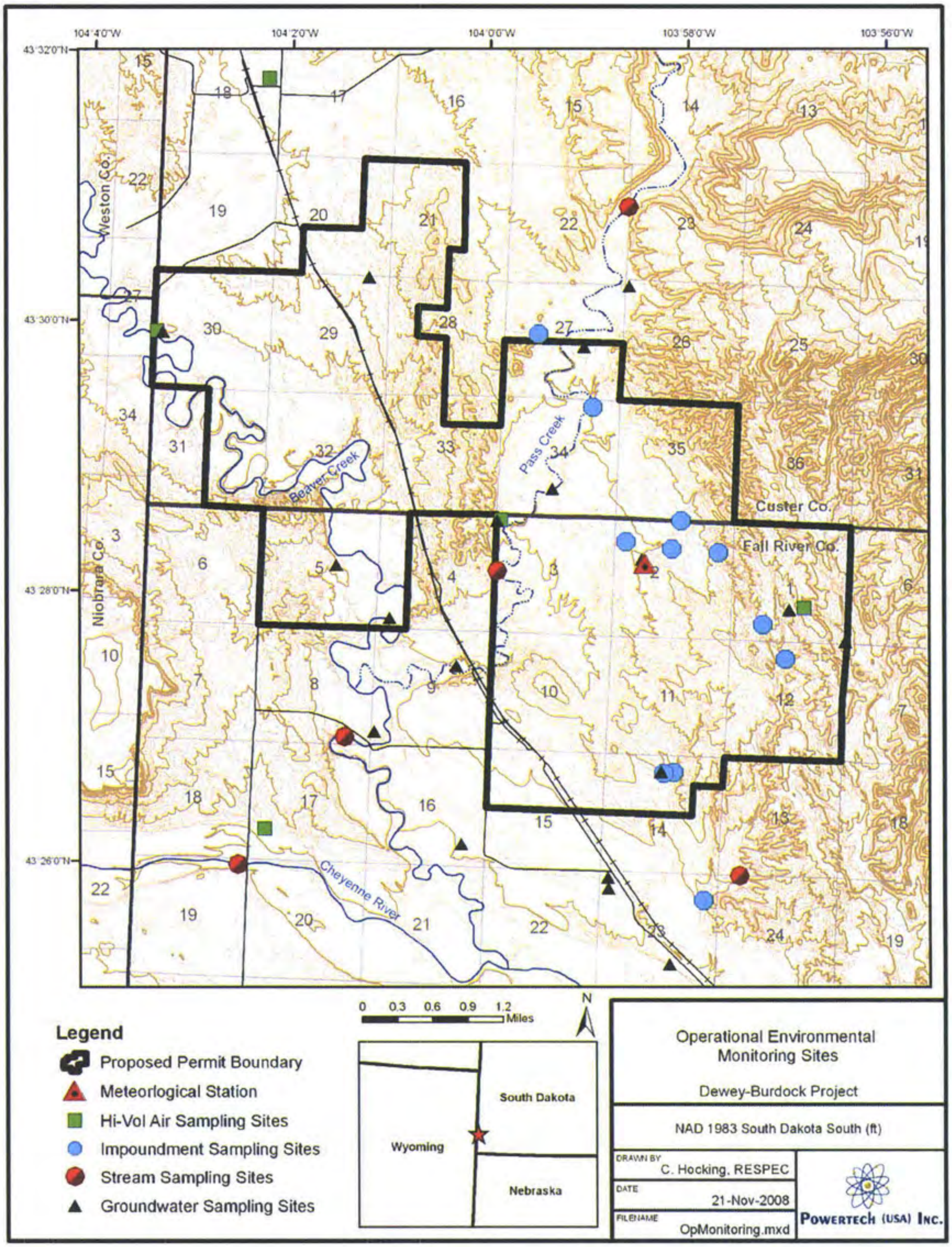

Figure 5.7-10: Operational Environmental Monitoring Sites

Additionally, effluents from the yellowcake dryer and packaging stacks will be sampled quarterly. The grab samples will be isokinetic in nature and will be analyzed for natural uranium, thorium-230, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with recommendations of RG 4.14.

5.7.7.2 Biota Monitoring

Samples of vegetation will be collected three times during the grazing season at each air monitoring station presented on Figure 5.7-10. At least three samples of livestock will be collected once a year, shortly after slaughter. The samples of vegetation and livestock will be analyzed for radium-226 and lead-210. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14 unless matrix interferences prohibit attainment of these low detection limit goals.

5.7.7.3 Surface Soil Monitoring

Samples of surface soil (0-5 cm) will be collected annually at each of the air monitoring stations shown in Figure 5.7-10. The samples will be analyzed for natural uranium, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14 unless matrix interferences prohibit attainment of these low detection limit goals.

5.7.8 Ground-Water and Surface-Water Monitoring Programs

Groundwater samples will be collected monthly for the first year of operation and quarterly thereafter at the groundwater monitoring well locations as shown in Figure 5.7-10. Quarterly samples will be collected from drinking water and livestock wells, included in the groundwater sampling sites as shown in Figure 5.7-10. Upstream and downstream surface water sampling (including passive sampling on Pass Creek) will be conducted monthly at the sampling locations shown in Figure 5.7-10. Surface impoundments will be sampled on a quarterly basis at the locations shown in Figure 5.7-10.

5.7.9 Quality Assurance Program

Powertech (USA) will establish a quality assurance program at the facility consistent with the recommendations contained in NRC Regulatory Guide 4.15 "*Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) -- Effluent Streams and the Environment*" (RG 4.15). The purpose of the program is to ensure that all radiological and nonradiological measurements that support the radiological monitoring program are reasonably valid and of a defined quality. These programs are needed (1) to identify deficiencies in the sampling and measurement processes and report them to those responsible for these operations so that licensees may take corrective action and (2) to obtain some measure of confidence in the results of the monitoring programs to assure the regulatory agencies and the public that the results are valid.

The quality assurance program will contain the following RG 4.15 elements:

- The organizational structure, responsibilities, and qualifications of both the management and the operational personnel.
- Specification and qualifications of personnel.
- The SOPs used in the monitoring programs.
- The records of samples, from collection to shipping to analysis.
- The records of quality control of the sample analyses, including results of quality control blanks, duplicates, and cross-checks performed by other laboratories.
- The calibration and operation of equipment used in obtaining samples, measuring radiation, etc.
- Data verification and validation procedures.
- The data and calculations used to determine concentrations of radioactive materials, radiation doses due to occupational exposure, etc.

Quality assurance procedures, as described in RG 4.14, Sections 3 will be defined for the following programs:

- External Monitoring Program
- Airborne Radiation Monitoring Program
- Contamination Control Program
- Airborne Effluent and Environmental Monitoring Program
- Management Control Program

Additionally, quality assurance recommendations contained in RG 4.14 and RG 8.22 will be incorporated in the environmental monitoring and bioassay programs, respectively. In general, the quality control requirements for a specific activity will be incorporated into the SOP for that activity.

The quality assurance program will be audited periodically. .The audits will be conducted by individuals qualified in radiochemistry and monitoring techniques. However, the auditors will not have direct responsibilities in the areas being audited. An example of an appropriate auditor is a consultant. The results of the audits will be documented and made available to members of management with authority to enact any changes needed (i.e. RSO, Mine Manager, etc.).

5.7.10 References

Energy Metals Corporation, U.S., "*Application for USNRC Source Materials License Moore Ranch Uranium Project, Campbell County, WY*"; Vol 1 Technical Report (2007).

NRCP Report No. 127, "*Operational Radiation Safety Program*", (June 12, 1998).

USNRC Regulatory Guide 4.14, "*Radiological Effluent and Environmental Monitoring at Uranium Mills*", (Revision 1, April 1980).

USNRC Regulatory Guide 4.15, "*Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Streams and the Environment*", (Revision 1, February 1979).

USNRC Regulatory Guide 8.13, "*Instruction Concerning Prenatal Radiation Exposure*" (Revision 3, June 1999).

USNRC Regulatory Guide 8.15, "*Acceptable Programs for Respiratory Protection*", (Revision 1, October 1999).

USNRC Regulatory Guide 8.22, "*Bioassay at Uranium Mills*", (Revision 1, August 1988).

USNRC Regulatory Guide 8.25, "*Air Sampling in the Workplace*", (Revision 1, June 1992).

USNRC Regulatory Guide 8.29, "*Instruction Concerning Risks From Occupational Radiation Exposure*", (Revision 1, February 1996).

USNRC Regulatory Guide 8.30, "*Health Physics Surveys in Uranium Recovery Facilities*", (Revision 1, May 2002).

USNRC Regulatory Guide 8.31, "*Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as is Reasonably Achievable*", (Revision 1, May 2002).

USNRC Regulatory Guide 8.36, "*Radiation Dose to the Embryo/Fetus*", (July 1992).

6.0 Groundwater Quality Restoration, Surface Reclamation, and Facility Decommissioning

6.1 Plans and Schedules for Groundwater Quality Restoration

Groundwater restoration, reclamation of disturbed land and decommissioning of the well fields, plant and associated facilities will be conducted in a manner that will protect human health and the environment. The methods for achieving this objective are discussed in the following sections.

6.1.1 Groundwater Restoration Criteria

Groundwater restoration at the proposed project site will be performed pursuant to NRC requirements to protect underground sources of drinking water (USDW) adjacent to the site. Prior to recovery, a Class III Underground Injection Control (UIC) Permit that includes an aquifer exemption from the EPA must be issued. This exemption will be based on historical and existing water quality, the demonstration that the ore zone is commercially producible and that the ore zone has not historically nor will it now or in the future be an underground source of drinking water.

The primary goal of groundwater restoration at the site will be to return groundwater quality within the production zone of a well field consistent with pre-operational baseline water quality conditions or to standards consistent with NRC's application of Criterion 5B(5) of Appendix A to 10 CFR Part 40. In the event that Powertech (USA) is unable to restore such groundwater consistent with preoperational baseline water quality conditions, the secondary goal would be to return water quality to its pre-operational livestock watering and agricultural class of use. Prior to operation, the baseline groundwater quality will be determined through the sampling and analysis of water quality indicator constituents in wells screened in the mineralized zone(s) across each well field. Based on statistical analysis of the data following ASTM Standard D 6312 (ASTM, 2001) to determine the baseline range of statistical variability of an indicator constituent; target restoration goals (TRG) will be established. Powertech (USA) will attempt to meet the TRG established for each constituent during the groundwater restoration process. Table 6.1-1 provided below lists the baseline water quality parameters and the methods that will be used for establishing groundwater TRG:

Table 6.1-1: Baseline Water Quality Parameters

Test Analyte/Parameter	Units	Method
BULK PROPERTIES		
pH	pH Units	A4500-H B
Total Dissolved Solids (TDS)	mg/L	A1030 E[1], A2540 C
Conductivity	µmhos/cm	A2510B
CATIONS/ANIONS		
Chloride	mg/L	E300.0
Sulfate	mg/L	E300.0
Total Alkalinity (as $CaCO_3$)	mg/L	A2320 B
TRACE METALS		
Arsenic, As	mg/L	E200.8
Iron, Fe	mg/L	E200.7
Lead, Pb	mg/L	E200.8
Manganese, Mn	mg/L	E200.8
Strontium	mg/L	E200.8
Uranium, U	mg/L	E200.8
Vanadium	mg/L	E200.7, E200.8
RADIONUCLIDES		
Gross Alpha=Alpha Particles	pCi/L	E900.0
Gross Beta=Beta Particles and Photons	mRem/Year	E900.0
Radium-226	pCi/L	E903.0
Radon-222	pCi/L	D5072-92

Table adapted from USNRC (2008) Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities-Draft Report for Comment. NUREG-1910. July 2008.
Notes: mg/L = milligrams per liter
µmhos/cm = micromhos per centimeter
pCi/L = picocuries per liter
All metals analyses are for dissolved metals

Powertech (USA) will consult with DENR concerning the specific groundwater suite of constituents prior to well field baseline evaluation. In the event that secondary groundwater restoration standards may need to be considered for specific constituents, Powertech (USA) will provide data and justification for restoring groundwater water quality to pre-operational class of use.

6.1.2 Estimate of Post-Production Groundwater Quality

In order to estimate post-production water quality from ISL operations at the site, Powertech (USA) has reviewed operational restoration water quality data from six ISL operations in the western United States. These sites include:

- Irigaray/Christensen Ranch (Wyoming)

- Crownpoint (New Mexico)
- Crow Butte (Nebraska)
- Bison Basin (Wyoming)
- Smith Ranch/Highland (Wyoming)
- Ruth (Wyoming)

Based on this review, the Crow Butte site was selected for the estimate because of the proximity and similar geologic conditions to the project site, available water quality data, reasonable pore volume estimates to achieve restoration and overall restoration success. The water quality data for the Crow Butte site is extensive with baseline, post-production, post-restoration, and stabilization period data. Baseline water quality, post-production water quality, post-restoration average water quality and stabilization period average water quality data are provided in Table 6.1-2 for the Crow Butte Mine Unit No.1. Powertech (USA) may expect similar baseline and post-production water quality results at the project site. The results of the restoration at the Crow Butte site are discussed in Section 6.1.5.

Table 6.1-2: Crow Butte Post Mining Water Quality Data Summary

Parameter	Baseline Water Quality	Post-Mining Water Quality	Post-Restoration Average Water Quality	Stabilization Period Average Water Quality
BULK PROPERTIES				
Specific Cond.	1947	5752	1620	1787
pH	8.5	7.35	7.95	8.18
TDS	1170.2	3728	967	1094
CATIONS/ANIONS				
Alkalinity	293	875	321	347
Chloride	204	583	124	139
Sulfate	356.2	1128	287	331
TRACE METALS				
Manganese	0.11	0.075	0.01	0.02
Arsenic	0.002	0.021	0.024	0.017
Iron	0.044	0.078	<0.05	0.09
Lead	0.031	<0.05	<0.05	<0.01
Uranium	0.092	12.2	0.963	1.73
Vanadium	0.066	0.96	0.26	0.11
RADIONUCLIDES				
Radium-226	229.7	786	246.7	303

Notes: All units in mg/L except for pH (standard units), radium (pCi/L), and specific conductivity (μmhos/cm).

6.1.3 Groundwater Restoration Methods

For ISL operations, a common commercial groundwater restoration program consists of a restoration stage and a monitoring stage. During restoration, groundwater will continue to be pumped from the well field, using a subset of wells that, during the production phase, functioned as either injection or production wells. The groundwater produced by these restoration wells will contain uranium and other constituents released during uranium production as well as residual lixiviant. Initial concentrations of these substances will be similar to those seen during production, but will decline gradually throughout the groundwater treatment process and further via the natural restoration process (NUREG/CR-3136, 1983). Water that is removed is first passed through the IX system to remove any available uranium.

Following IX, the groundwater will be treated by reverse osmosis to concentrate contaminants into a reject brine stream that is then injected into Class I or V disposal wells. An alternate disposal method consisting of treatment to remove contaminants followed by storage and land application to produce an agricultural crop is also presented.

The specific method of groundwater restoration selected for the Dewey-Burdock project will depend on which option; injection into a disposal well or treatment and land application, or combination thereof, as described in Section 6.1.9, is utilized for disposition of the wastewater from the restoration well fields.

The stability monitoring stage includes a period in which the indicator parameters identified in Section 6.1.1 are monitored in order to establish successful restoration consistent with NRC requirements.

6.1.3.1 Groundwater Treatment

The groundwater treatment method of restoration is similar to the injection sweep method in that uncontaminated water is injected in perimeter wells. In this method of restoration, the groundwater removed during restoration is treated by reverse osmosis to divide it into a permeate stream containing most of the water, but little of the dissolved solids in the restoration flow, and a reject stream containing a relatively small portion of the volumetric flow, but a large fraction of the dissolved solids. The permeate stream is relatively uncontaminated and is a suitable source for a portion of the uncontaminated water injected at the perimeter of the well field. In addition to this permeate recycle, a make-up stream of fresh water from an outside well will be required, as described in the injection sweep method, but requiring a much smaller amount of this water from an outside source. The reject stream is then disposed of in a suitable deep disposal well, as described in Section 6.1.9.

The wastewater system, disposal well injection and land application descriptions are discussed in further detail in Section 4.0.

6.1.4 Restoration Schedule

The proposed project restoration schedule, Figure 6.1-1, shows the estimated schedule for restoration. This is a preliminary schedule based on current knowledge of the area, and is based on completion of the production activities for both the Dewey and Burdock sites. As the project is developed, the restoration schedule will be further refined.

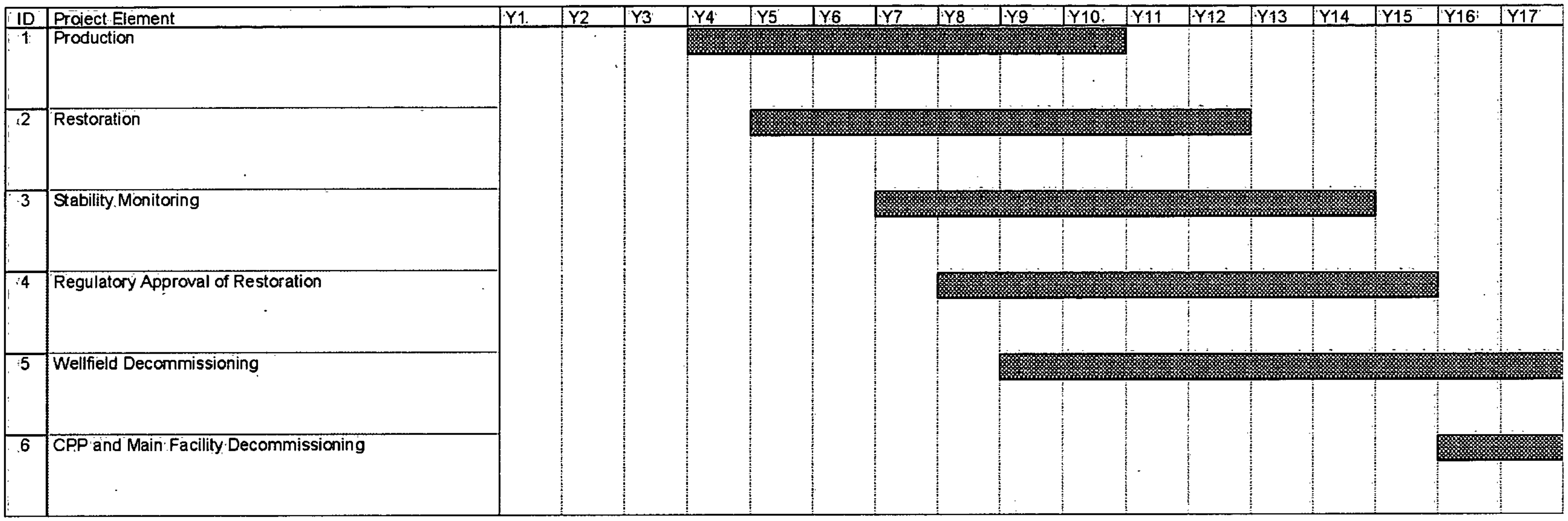

Figure 6.1-1: Proposed Project Operations and Restoration Schedule

6.1.5 Effectiveness of Ground Water Restoration Techniques

The groundwater restoration methods described in this application have been successfully applied at other uranium ISL facilities in the US, including Irigaray/Christensen Ranch in Wyoming and Crow Butte in Nebraska.

6.1.5.1 Irigaray/Christensen Ranch

The Irigaray/Christensen Ranch ISL sites are located in the Powder River Basin approximately 50 miles to the southeast of Buffalo, Wyoming (USEPA, 2008). The ore mineralization occurs as a roll-front deposit in the Eocene Wasatch Formation.

Reverse osmosis was used to treat well field bleed water for use in restoration. Water quality of the Irigaray ore zone after production was measured by sampling each of the designated restoration wells and comparing results to baseline water quality data. Most of the 30 parameter concentrations in the post-production data exceeded the baseline means. Several of these parameters did not meet Restoration Target Values (RTV) established for the site (EMC, 2007).

Groundwater restoration results at the Irigaray/Christensen Ranch site were approved by the NRC and WDEQ following commercial operations and groundwater restoration at well fields 1 through 9. Post-production water quality in the nine production units was described above. Restoration water quality data were not available for this report. After restoration, twenty-seven of twenty-nine constituents were restored below the restoration target values as approved by the WDEQ using 9.5 to 18.4 pore volumes (USNRC, 2008). Bicarbonate and manganese were the only constituents that exceeded baseline ranges. However, WDEQ ruled that these constituents met the criteria of pre-production class of use. Therefore, the WDEQ determined that post restoration groundwater conditions did not significantly differ from the background water quality and groundwater, as a whole, had been returned to its pre-production class of use. In 2006, the NRC concurred with WDEQ's determination that groundwater restoration was complete at the site.

6.1.5.2 Crow Butte

The Crow Butte ISL site is located in Dawes County Nebraska just southeast of the town of Crawford (Collins and Knode, 1984). Roll-front ore deposits are concentrated in the Basal Chadron Sandstone, which is a member of the Paleocene White River Group. Coffinite is the major uranium mineral associated with the deposit. Matrices minerals include quartz, feldspar, mafic minerals, pyrite, and clays.

Restoration of commercial Mine Unit No. 1 took approximately five years after beginning in 1994 (USNRC, 2007b). The restoration process consisted of groundwater transfer (0.89 pore volumes), groundwater sweep (0.09 pore volumes), groundwater treatment with IX (26.62 pore volumes), groundwater treatment with reverse osmosis (6.02 pore volumes) and well field recirculation (2.85 pore volumes). Thus, a total 36.47 pore volumes was processed in the restoration steps listed above (Crow Butte Resources, 2000). The NRC originally denied restoration approval for Mine Unit No. 1 due to concentrations of ammonium, iron, radium-226, selenium, total dissolved solids, and uranium that showed increasing trends during the six-month stability monitoring period. Therefore, the NRC requested additional stability monitoring for these parameters which was performed and submitted by Crow Butte Resources (Crow Butte Resources, 2001). The NRC then approved the restoration of Mine Unit No. 1 in 2003 (USNRC, 2007b).

The NRC approved the completion of groundwater restoration program for Well field No. 2 after the removal of approximately 19 pore volumes and recirculation of approximately 16.4 pore volumes (USNRC, 2007b).

6.1.6 Environmental Effects of Groundwater Restoration

Based on the success of groundwater restoration at other ISL facilities, Powertech (USA) expects that the proposed groundwater restoration techniques will be successful at returning the production zones within the PAA to restoration target values. The purpose of restoring the groundwater to these indicator parameters is to protect USDWs adjacent the aquifer exemption boundary. Powertech (USA) believes that by using proven best practicable technology for groundwater restoration combined with federal and state regulatory requirements will ensure that potential impacts to groundwater quality outside the production zone are mitigated.

The preferred method of restoration consists of using the groundwater treatment method with RO reject brines being disposed in a Class I or V disposal well located in the Minnelusa aquifer within the permit boundary. This method minimizes the amount of groundwater that will be consumed during restoration, and minimizes the surface disturbance to land within the permit boundary. It further eliminates the need for additional processing facilities, beyond RO, to concentrate and remove radium and other contaminants prior to land application. Disposal of wastewater in deep disposal wells is the best practicable technology and is the standard method used at most ISL uranium mines. The alternate method of land application would consume more groundwater since none of the restoration water would be recycled to the well field, but would be used in a once-through process leading to land application.

The proposed restoration methods will consume groundwater. Groundwater recovered during groundwater restoration is typically disposed of directly in the wastewater system. Consumption of groundwater is an unavoidable consequence of groundwater treatment; potential impacts and water usage during operations is discussed in more detail in Section 7.2.5.1.

6.1.7 Groundwater Restoration Monitoring

6.1.7.1 Monitoring During Active Restoration

During restoration, lixiviant injection is discontinued and the quality of the groundwater is constantly being improved. As a result, the possibility of an excursion is greatly reduced. The monitor ring wells, overlying aquifer wells, and underlying aquifer wells will be sampled once every 60 days during restoration. The wells will be analyzed for the water quality indicator parameters provided in Table 6.1-1. Water levels at these wells are also obtained prior to sampling. The NRC will be contacted if any of the wells cannot be monitored within 65 days of the last sampling event due to unforeseen conditions such as snowstorms, flooding, and equipment malfunctions.

6.1.7.2 Restoration Stability Monitoring

A minimum six month groundwater stability monitoring period will be implemented to show that the restoration goal has been adequately maintained. During the stability period, the following restoration stability monitoring program will be utilized:

- Monitoring ring wells will be sampled once every two months and analyzed for the indicator parameters, which include: chloride, total alkalinity (or bicarbonate), and conductivity.
- At the beginning, middle, and end of the stability period, the production wells will be sampled and analyzed for the indicator parameters listed in Table 6.1-1 (Baseline Water Quality Parameters).

The NRC will be contacted if any of the wells cannot be monitored within 65 days of the last sampling event due to unforeseen conditions such as snowstorms, flooding, and equipment malfunctions.

6.1.8 Well Plugging and Abandonment

Prior to plugging, each well will undergo mechanical integrity testing (MIT) to demonstrate the integrity of casing and cement that will be left in the ground after closure. Alternatively, cementing records or other evidence (such as cement bond logs) will be used to show that an adequate quantity of cement is present to prevent upward fluid movement within the borehole outside of the casing. If it cannot be verified that a well casing is grouted properly, an effort will be made to plug the annulus from the bottom of the annulus to the ground surface, using the same materials required for plugging the inside of the casing as described below.

Wells will be opened and debris and downhole equipment such as the tubing, pumps and screens will be removed to prevent obstacles from interfering with plugging operations. The wellhead and casing will be removed to three (3) feet below ground surface. A tremie pipe will be used to add grout to wells that are more than 40 feet deep.

Injection, extraction and monitoring wells that are completed into a confined aquifer or multiple aquifers will be plugged with bentonite grout provided the weight of the bentonite grout column will be sufficient to overcome the bottom hole pressure. If bentonite grout will not be sufficient, cement grout will be placed from the bottom of the well to within eight (8) feet of the ground surface. Cement grout will be placed from eight (8) feet below ground surface to within three (3) feet of the ground surface. The top three (3) feet of the well will be backfilled with native material and reclaimed. If a tremie pipe cannot be lowered inside the well-casing for grout placement a tight connection will be made to the top of the casing in order to pump a sufficient volume of cement grout down to fill the well, under pressure. Bentonite grout will not be used if the tight connection method is used. Figure 6.1-2 shows a generalized schematic of a plugged and abandoned well completed into a confined aquifer or multiple aquifers.

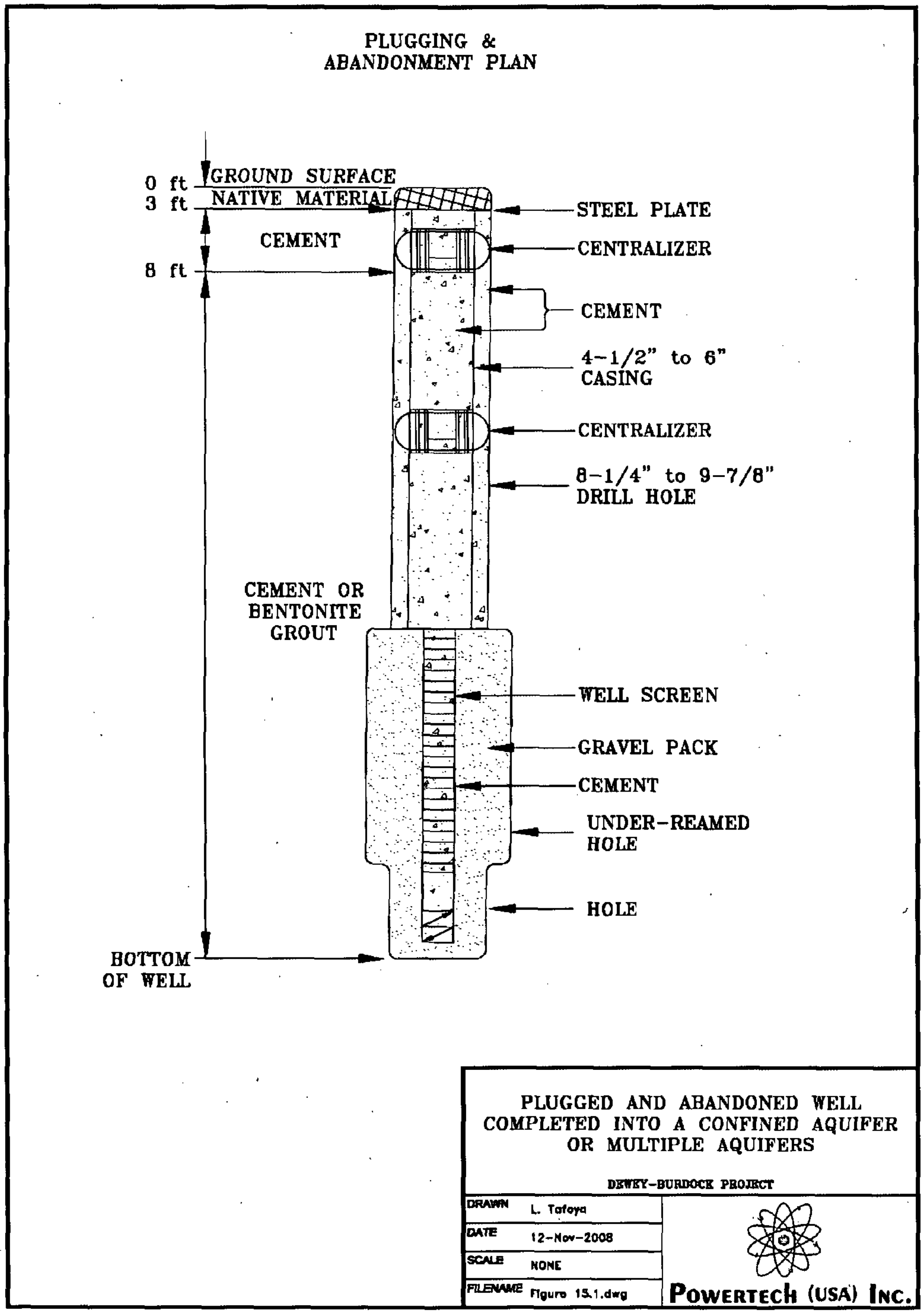

Figure 6.1-2: Plugged and Abandoned Well Completed into a Confined Aquifer or Multiple Aquifers

Wells completed into an unconfined aquifer where a single aquifer is encountered will be backfilled with clean sand or gravel to the top of the aquifer. Above the aquifer, clay, bentonite grout, or cement grout will be used for plugging to within at least 3 feet of the ground surface. If clay is used as the backfill material, a minimum of 2-feet of dry bentonite, bentonite grout, or cement grout will be placed at the top of the aquifer. The top 3-feet of the casing or hole, if not filled with clay, bentonite grout, or cement grout will be backfilled with native material and reclaimed. Figure 6.1-3 shows a generalized schematic of a plugged and abandoned well completed into an unconfined aquifer.

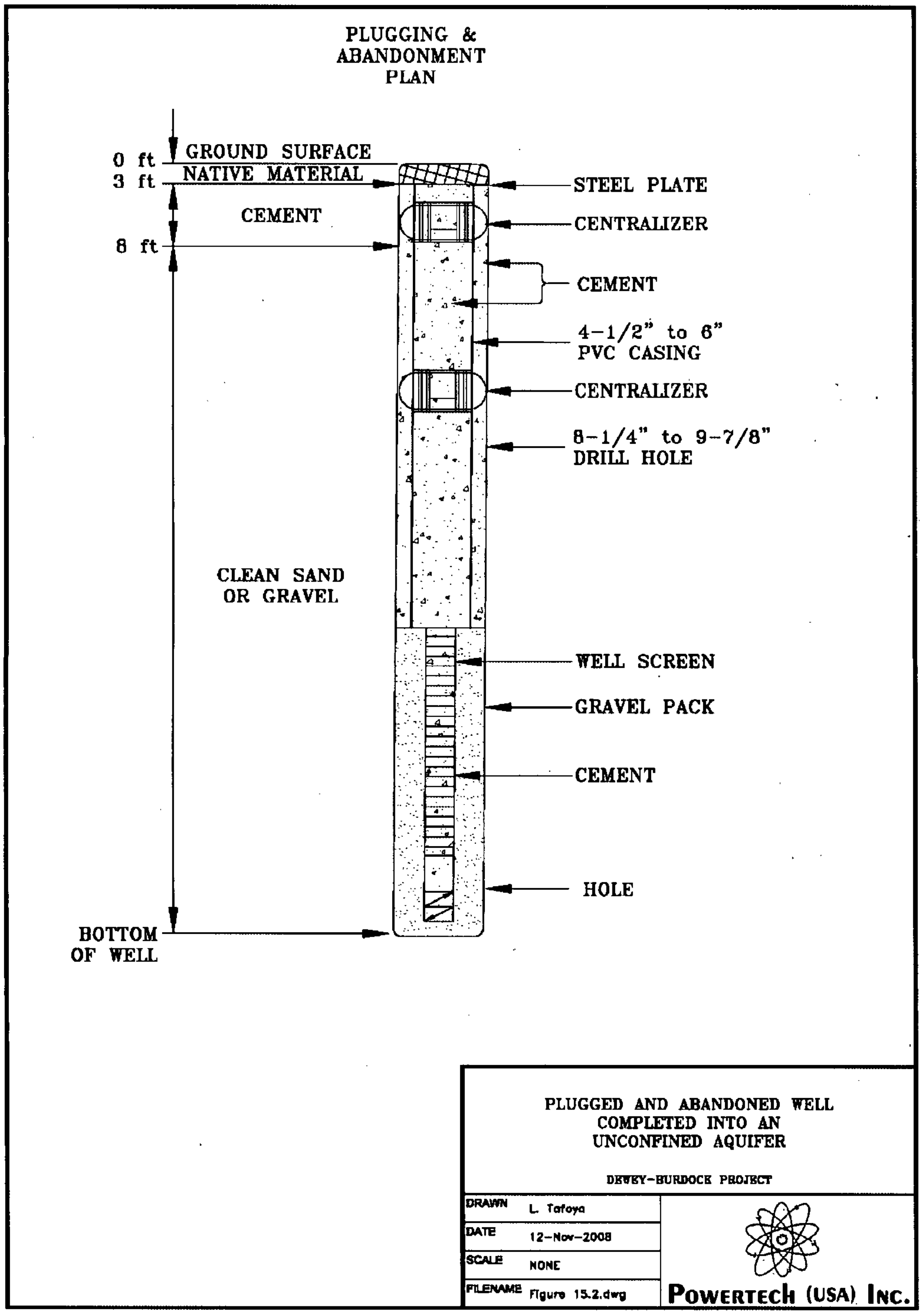

Figure 6.1-3: Schematic of Plugged and Abandoned Well in an Unconfined Aquifer

Bentonite grout, composed of commercially manufactured sodium bentonite material specifically formulated for well casings, will be mixed according to manufacturer's recommendations and will contain a minimum of 20 percent solids by weight and have a minimum slurry density of 9.4 pounds per gallon. Cement plugs will consist of neat cement grout prepared in the same manner as used for well construction. Specifically, cement grout will be composed of high sulfate resistant Portland cement using no more than 6 gallons of clean water for each 94-pound sack of cement to yield a slurry weight of approximately 13 pounds per gallon. Water used to make the cement grout will not contain oil or other organic material. Cement grout may contain as much as 2 pounds of bentonite per 94-pound bag of cement. Up to 7 gallons of clean water may be added when 2 pounds of bentonite are added per 94-pound bag of cement.

Grout will be allowed to set for approximately 24 hours in the borehole. If the grout settles less than 40 feet below ground surface the top of the well will be sealed with additional grouting material as described above. If the grout settles more than 40 feet below ground surface, additional grout will be introduced on top of settled grout through a tremie pipe.

A steel plate will be placed on top of the sealing mixture with the permit number, date of plugging and well identification number clearly displayed. The tag will be affixed to the top of the plug at a minimum depth of 2 feet below ground surface. The locations of the abandoned wells will be identified by recording the boundaries of each well field and the location of the monitor well ring around each well field as a deed notice with the appropriate county.

Wells in which water is not encountered or only low-permeability formations such as clays, shales, or till are encountered will be backfilled with material free of contamination. In order to restore the natural conditions as much as possible, the fill will have a permeability less than or equal to the permeability of the formations encountered.

6.1.9 Restoration Wastewater Disposal

As noted earlier, the method of wastewater disposal is closely linked to the choice of groundwater restoration methods. The preferred option is to dispose of wastewater by injection into a Class I or V disposal well within the Minnelusa formation (Section 2.6). Such wells would best be located within the permit boundary and therefore within the state of South Dakota. An alternate location for these wells would be just over the western border of the permit boundary in the state of Wyoming.

If disposal wells are available, wastewater will be processed in a reverse osmosis operation as described in Section 6.1.3.2. The reject stream from the reverse osmosis unit, containing the concentrated solids from the restoration water, may be combined with other concentrated wastewater streams from a reverse osmosis unit on an operating well field in the production phase and with the spent brine from the CPP. The combined wastewater stream will then be injected into these disposal wells as a final disposition. A restoration flow diagram with waste disposal well shown on Figure 6.1-4.

If disposal wells are unavailable in both states, wastewater will be disposed of by applying it to the surface of the ground for agricultural irrigation. In this case, groundwater removed during groundwater sweep operations is passed through an additional IX step to reduce concentrations of any undesirable constituents still remaining after the primary IX step. Following these treatments, the wastewater will be treated to remove radium by precipitation with barium chloride. A small amount of barium chloride solution is mixed with the wastewater. The naturally occurring sulfate within the wastewater will chemically bond with the barium and radium, causing barium sulfate and radium sulfate to form as an insoluble precipitate. If sulfate levels are low, sulfate ions may be added prior to the barium addition step by the injection of an ammonium sulfate solution. The wastewater stream is then directed to a settling pond where the insoluble precipitate will settle out. The supernatant water from the pond will be suitable for land application via a number of center-pivot irrigation sprinkler systems as described in Section 3.1.6. The radium-bearing pond sludge will accumulate in the ponds and will periodically be removed for disposal at an NRC approved facility for 11e.(2) byproduct materials. A restoration flow diagram with land application is shown on Figure 6.1-5.

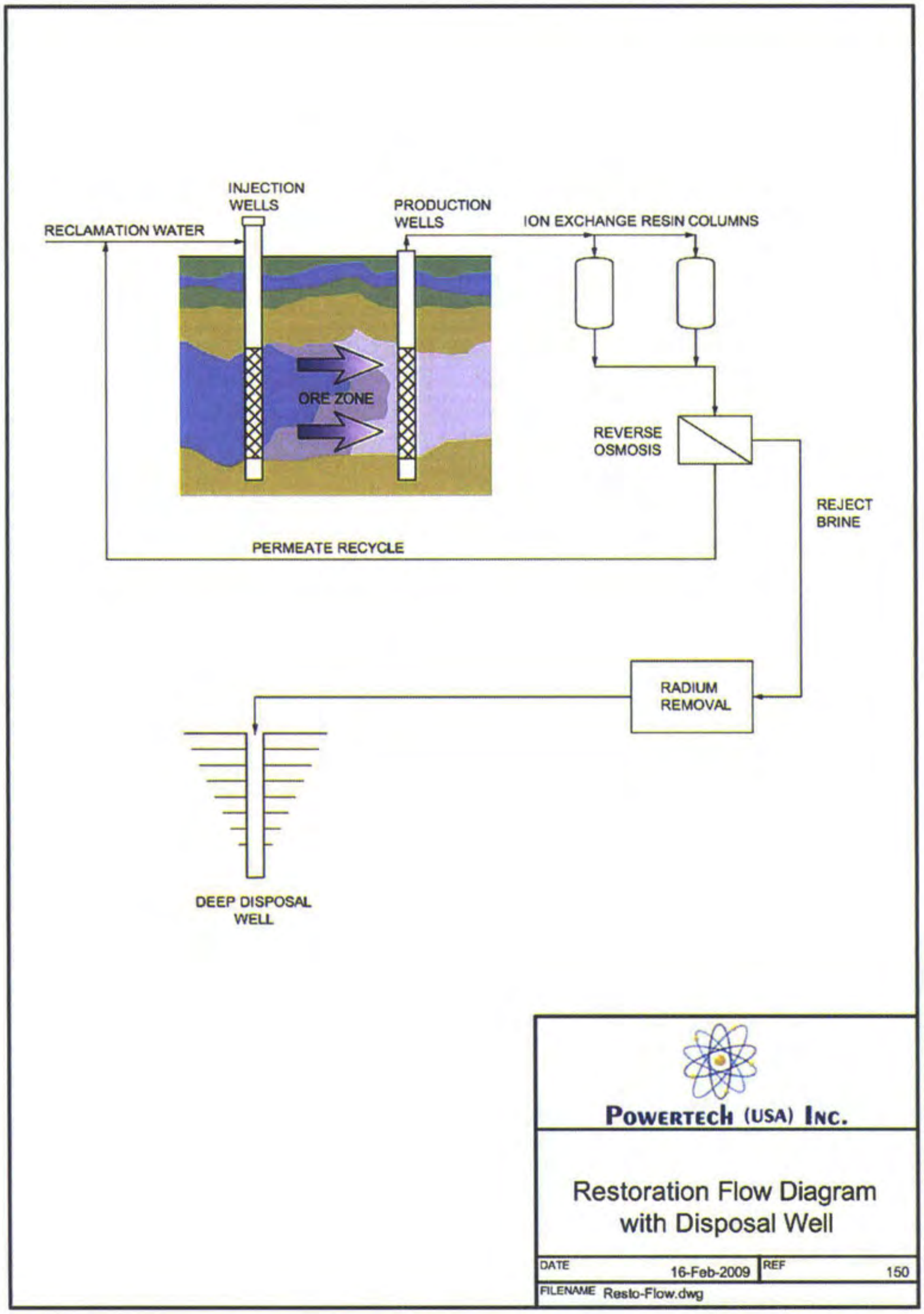

Figure 6.1-4: Restoration Flow Diagram with Disposal Well

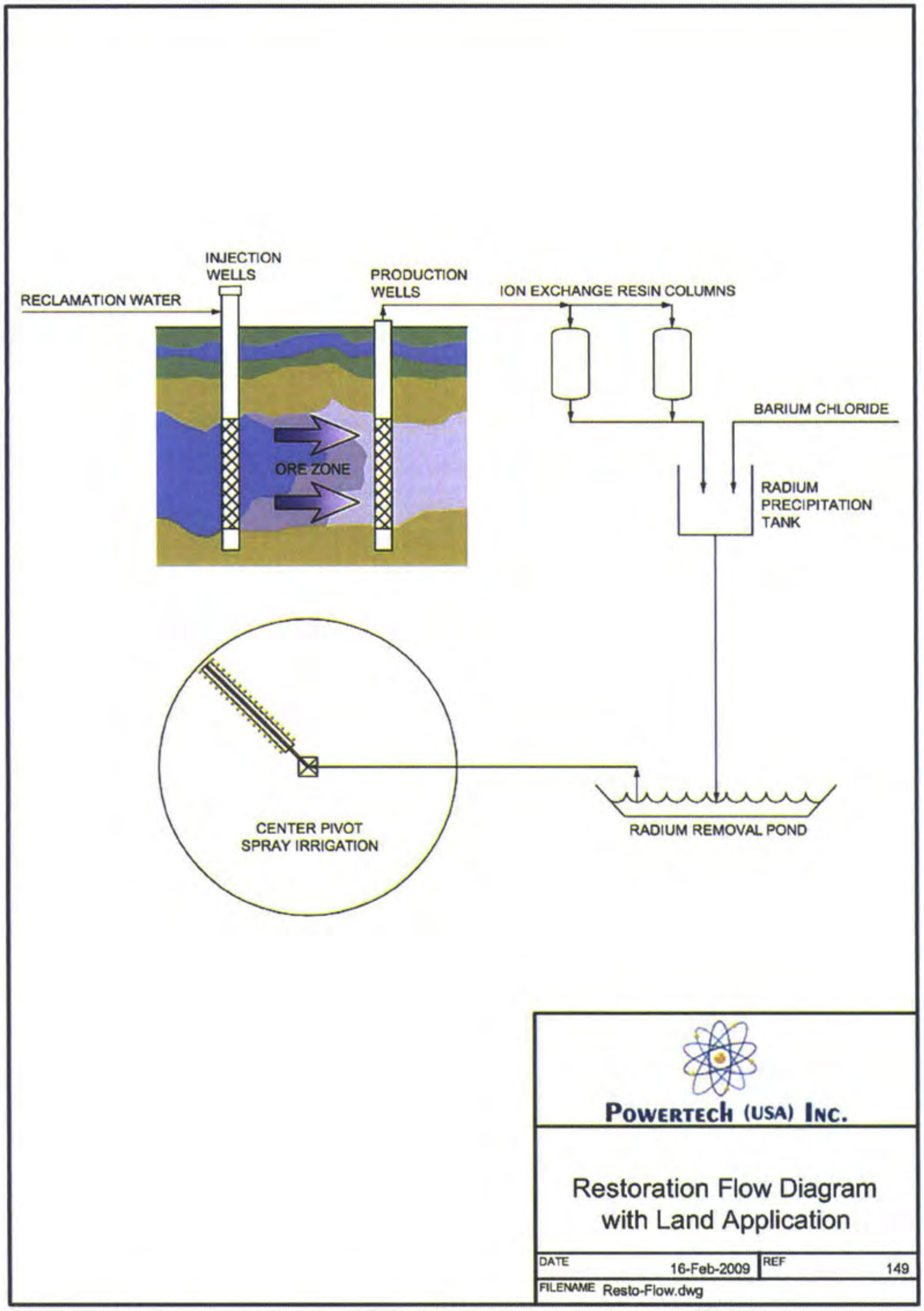

Figure 6.1-5: Restoration Flow Diagram with Land Application

6.1.10 References

Collins S.T. and Knode R.K., 1984, "*Geology and Discovery of the Crow Butte Uranium Deposit*", Dawes County, Nebraska.

Energy Metals Corporation (EMC), 2007, "*License Application, Technical Report, Moore Ranch Uranium Project*", USNRC Accession Number ML072851268, 297 p.

United States Environmental Protection Agency (USEPA), 2008, Appendix III to unidentified document, Web Site http://www.epa.gov/rpdweb00/docs/tenorm/402-r-08-005-voli/402-r-08-005-v1-apps.pdf

United States Nuclear Regulatory Commission (USNRC), 2007a, "*Final Environmental Impact Statement to Construct and Operate the Crownpoint Solution Mining Project*", Crownpoint, New Mexico, USNRC NUREG-1508.

United States Nuclear Regulatory Commission, 2007b, "*Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities*", USNRC NUREG/CR-6870.

6.2 Plans and Schedules for Reclaiming Disturbed Lands

6.2.1 Introduction

At the completion of the project, all disturbed lands will be returned to their pre-production land use of livestock grazing and wildlife habitat. The objective of the surface reclamation effort is to return the disturbed lands to equal or better condition than pre-production. All buildings and structures will be decontaminated to regulatory standards and demolished and trucked to an approved disposal facility. Baseline soils, vegetation, and radiological data will be used as a guide in evaluating the final reclamation. A final decommissioning plan will be submitted to the NRC for review and approval at least 12 months prior to the planned decommissioning of a well field or PAA.

6.2.2 Surface Disturbance

Due to the nature of ISL production, minimal and intermittent surface disturbance will be associated with the project, and will be mainly associated with the CPP, maintenance and office areas. Additional intermittent disturbance occurs in the well fields, which includes well drilling, pipe installations, and road construction; however, disturbances associated with the well field impact a relatively small area and have short-term impacts.

Surface disturbances associated with the construction of the CPP, office and maintenance buildings, and well field header houses will be for the life of those activities. Topsoil will be stripped and stockpiled from these areas prior to construction. Disturbances associated with the well field drilling and pipeline installation are limited and will be reclaimed as soon as possible after these components are completed. Surface disturbance associated with the development of access roads will occur at the project site; topsoil will be stripped from the road areas and stockpiled prior to construction.

While, the PAA encompasses 10,580 acres, the land potentially disturbed by the PAA will be approximately 68 acres (facilities, piping, ponds, well fields and roads) the year proceeding operation. The disturbed area during the life of the project (production to restoration) is estimated to increase over time to a maximum of 108 acres. If the maximum area for land application of treated wastewater is included in the footprint of the PAA, then approximately a maximum additional 355 acres would be affected by the PAA for most of the project life. The maximum potential disturbance at any given time is expected to be 463 acres.

6.2.3 Topsoil Handling and Replacement

Topsoil will be salvaged from any building sites, permanent storage areas, access roads, and chemical storage areas prior to construction in accordance with SD DENR requirements. Typical earth moving equipment such as rubber tired scrapers and front end loaders will be used for topsoil stripping. In the well field, topsoil removal will be limited to headerhouse locations and access roads. A total of an estimated 13 acres of topsoil will be stripped, stockpiled, and replaced during the life of the project.

Salvaged topsoil will be stored in designated topsoil stockpiles. These stockpiles will be located such that losses from wind erosion are minimized. Additionally, topsoil stockpiles will not be located in any drainage channels or other locations that could lead to a loss of material. Berms will be constructed around the perimeter of stockpiles and the stockpile will be seeded with an approved seed mix to help minimize sediment runoff. Additionally, all topsoil piles will be identified with highly visible signs per SD DENR requirements.

During excavations of mud pits associated with well construction, exploration drilling, and delineation drilling activities, topsoil is separated from the subsoil with a backhoe. First the topsoil is removed and placed at a separate location and then the subsoil is removed and deposited next to the mud pit. Usually within 30 days of the initial excavation use of the mud pit is complete; the subsoil is redeposited in the mud pit followed by the replacing of topsoil. Pipeline ditch construction follows a similar procedure storing topsoil and subsoil separately and depositing the topsoil on the subsoil after the ditch has been backfilled.

6.2.4 Final Contouring

Due to the nature of ISL production, there will be very few construction activities that will require any major contouring during reclamation. Surface disturbances that do occur will be contoured to blend in with the natural terrain. Since no major changes in the topography will result from the proposed action, a final contour map has not been included.

6.2.5 Revegetation Practices

Revegetation practices will be conducted in accordance with NRC and DENR regulations and the methods outlined in the SD DENR mining permit. In order to help reduce wind and water erosion, topsoil stockpiles and other various disturbances in the well field area will be seeded throughout the PAA. Per SD DENR regulations, the seed mix will be chosen to be compatible with the post-production land use. The local conservation district, landowners and the SD DENR will be consulted when selecting the seed mix.

A reference area may be used to measure the success of reclamation. The reference area will be selected in a location that will not be affected by future production and is representative of the post-production land use. It will be managed such that there are no significant changes in cover, productivity, species diversity and composition of the vegetation.

Seeding may be done with a rangeland drill or with a broadcast seeder where practical. After topsoil preparation is completed affected lands will be seeded during the first normal period of favorable planting conditions unless an alternative plan has been approved. Any gullies or rills that would preclude the successful establishment of vegetation or achievement of the post-production land use will be removed or stabilized as part of the revegetation and reclamation process.

6.3 Procedures for Removing and Disposing of Structures and Equipment

The procedures for removing and disposing of structures and equipment include the establishment of surface contamination limits, preliminary radiological surveys of process building surfaces, equipment and piping systems; strategic cleanup and removal of process building materials and equipment, sorting materials according to contamination levels and salvageability, and preparing materials for transport and offsite use or disposal. Although not mentioned hereafter, the procedures also apply to tools and other equipment, such as backhoes.

All decommissioning activities will be done in accordance with the NRC license, Titles 10 and 49 of the CFR, and other applicable regulatory requirements.

6.3.1 Establishment of Surface Contamination Limits

Surface contamination release limits will be adopted from those published in NRC Regulatory Guide 1.86, Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use of Termination of Licenses for Byproduct, Source, or Special Nuclear Material (NRC, 1987), or modeled using RESRAD Build, or equivalent. Powertech (USA) will select the methods by which surface contamination limits will be developed at a later date.

6.3.2 Preliminary Radiological Surveys and Contamination Control

Powertech (USA) will develop one or more characterization plans that it will follow to demonstrate compliance with the surface contamination limits for building materials, systems, and equipment. The characterization plan(s) will include guidance and SOPs to conduct the preliminary surveys and control contamination.

Areas within buildings showing evidence of possible penetration of process solutions will be evaluated for possible subsurface contamination. If building materials, slabs and soils beneath the slabs are not contaminated, the buildings shall be released for unrestricted use, provided the building surfaces meet the release criteria and radiological monitoring requirements of the characterization and verification plans. Otherwise, the buildings will be demolished, the slabs removed, and the underlying soils removed (if contaminated). All materials contaminated above release limits will be prepared for offsite disposal at a licensed disposal facility. Contamination control will be addressed using operational SOPs, in conjunction with radiological surveys.

6.3.3 Removal of Process Building and Equipment

Powertech (USA) will develop plans for the strategic removal of process building and equipment, based on inventory, the results of the radiological surveys, decontamination options and available methods, reuse/disposal pathways, and information obtained during the effort. To the extent possible, Powertech (USA) intends to decontaminate salvageable equipment for unrestricted release. Decontamination methods may include a combination of washing, high pressure sprays, or steam cleaning. Cleaned surfaces will be air-dried prior to radiological monitoring. The ALARA principle applies to decommissioning activities. As such, surface contamination will be reduced to levels as far below applicable limits as practical.

Powertech (USA) will document the results of radiological surveys for all building materials, systems, and equipment. These items will be sorted as follows:

- Salvageable and contaminated above release limits (not releasable but potentially disposable or transferrable)
- Salvageable and contaminated below release limits (releasable) for unrestricted use
- Not salvageable and contaminated above release limits (offsite disposal at a facility licensed to accept 11e.(2) byproduct material)

- Not salvageable and contaminated above release limits (offsite disposal at a permitted facility)

In the first case, the item may be transferred to another NRC or Agreement State licensee. If it cannot be transferred or decontaminated to be released for unrestricted use, it will be disposed of at a licensed disposal facility. In all cases, Powertech (USA) will strictly maintain an inventory of all process building and equipment and the results of radiological surveys.

6.3.3.1 Building Materials, Equipment and Piping to be Released for Unrestricted Use

Powertech (USA) will develop an approved standard operating procedure for release of items to unrestricted use and thoroughly document all items eligible for release to unrestricted use. To the extent possible, releasable items having a salvageable value will be sold on the industrial market. Releasable items having no net salvageable value will be sent to a municipal landfill.

6.3.3.2 Preparation for Disposal at a Licensed Facility

All materials and plant equipment unsuitable for unrestricted release will be prepared for offsite disposal at a licensed facility. Building materials, tools, and equipment destined for offsite disposal will be prepared for transportation and disposal in accordance with 49 CFR and other applicable requirements.

6.3.4 Waste Transportation and Disposal

Waste transportation will be performed in accordance with 49 CFR and all other applicable regulations. Offsite shipments will be properly prepared, in terms of packaging, marking and labeling, dose rate measurements, shipping papers, and emergency contact information. Offsite disposal will be conducted in accordance with disposal facility licensing requirements, including waste characterization and profiling.

Powertech (USA) will maintain a strict inventory of materials sent for disposal in a municipal landfill, i.e., those that are both non-salvageable and meet the requirements of unrestricted release. In all cases, Powertech (USA) will couple the ultimate destinations of all items to its origin, date of generation, and the results of radiological surveys.

6.4 Methodologies for Conducting Post-Reclamation and Decommissioning Radiological Surveys

6.4.1 Cleanup Criteria

Surface soils will be cleaned up in accordance with requirements contained in 10 CFR Part 40, Appendix A, including considerations of ALARA goals and the chemical toxicity of Uranium. On April 12, 1999, the U.S. NRC issued a Final Rule (64 FR 17506) that requires the use of the existing soil radium standard to derive a dose criterion for the cleanup of byproduct material. The amendment to Criterion 6 (6) of 10 CFR Part 40, Appendix A was effective on June 11, 1999. This "benchmark approach" requires that NRC licensees model the site-specific dose from the existing radium standard and then use that dose to determine the allowable quantity of other radionuclides that would result in a similar dose to the average member of the critical group. These determinations must then be submitted to NRC with the site reclamation plan or included in license applications. This report documents the modeling and assumptions made by Powertech (USA) to derive a standard for U-nat in soil for the proposed project ISL facility.

Concurrent with publication of the Final Rule, NRC published draft guidance (64 FR 17690) for performing the benchmark dose modeling required to implement the final rule. Final guidance (NRC, 2003) was published as Appendix E to the Standard Review Plan for *In Situ* Leach License Applications (NUREG-1569). This guidance discusses acceptable models and input parameters. This guidance from the RESRAD Users Manual (ANL, 2001), the Data Collection Handbook (ANL, 1993) and site-specific parameters were used in the modeling as discussed in the following sections.

6.4.1.1 Determination of Radium Benchmark Dose

RESRAD Version 6.4 computer code (RESRAD) was used to model the ISL site and calculate the maximum annual dose rate from the current radium cleanup standard.

The following supporting documentation for determination of the radium benchmark dose and the natural uranium soil standard (explained in Section 6.4.1.2) is attached in the Appendix 6.4-A (Radium Benchmark Dose Assessment, ERG, Inc., Oct., 2008):

- The RESRAD Data Input Basis (Attachment 1 of Appendix 6.4-A) provides a summary of the modeling performed with RESRAD and the values that were used for the input parameters. A sensitivity analysis was performed for parameters which are important to the major component dose pathways and for which no site specific data was available.

- Selected graphs produced with RESRAD that present the results of the sensitivity analysis performed on the input parameters are attached (Attachment 2 of Appendix 6.4-A).
- A full printout of the final RESRAD modeling results for the resident farmer scenario with the chosen input values is attached (Attachment 3.0 and 3.1 of Appendix 6.4-A). The printout provides the modeled maximum annual dose for calculated times for the 1,000-year time span and provides a breakdown of the fraction of dose due to each pathway.
- Graphs produced with RESRAD that present the modeling results for the maximum dose during the 1,000 year time span for radium-226 and natural uranium. A series of graphs depicting the summed dose for all pathways and the component pathways that contributes to the total dose are attached (Attachment 4.0 and 4.1 of Appendix 6.4-A).

The maximum dose from Ra-226 contaminated soil at the 5 pCi/g above background cleanup standard, as determined by RESRAD, for the residential farmer scenario was 38.1 mrem/yr. This dose was based upon the 5 pCi/g surface (0 to 6-inch) Ra-226 standard and was noted at time, t = 0 years. The two major dose pathways were external exposure and plant ingestion (water independent). For these two pathways, a sensitivity analysis was performed for important parameters for which no site specific information was available. The 38.1 mrem/yr dose from radium is the level at which the natural uranium radiological end point soil standard will be based as described in the following section.

6.4.1.2 Determination of Natural Uranium Soil Standard

RESRAD was used to determine the concentration of natural uranium (U-nat) in soil distinguishable from background that would result in a maximum dose of 38.1 mrem/yr. The method involved modeling the dose from a set concentration of U-nat in soil. This dose was then compared to the radium benchmark dose and scaled to arrive at the maximum allowable U-nat concentration in soil.

For ease of calculations, a preset concentration of 100 pCi/g U-nat was used for modeling the dose. The fractions used were 49.2 percent (or pCi/g) U-234, 48.6 percent (or pCi/g) U-238 and 2.2 percent (or pCi/g) U-235. The distribution coefficients that were selected for each radionuclide were RESRAD default values. All other input parameters were the same as those used in the Ra-226 benchmark modeling.

Using a U-nat concentration in soil of 100 pCi/g, RESRAD determined a maximum dose of 7.1 mrem/yr. at time, t = 0 years. The printout of the RESRAD data summary is provided in

Attachment 3.1 of Appendix 6.4-A and the dose figures generated with RESRAD are provided in Attachment 4.1 of Appendix 6.4-A.

To determine the uranium soil standard, the following formula was used:

$$\text{Uranium Limit} = \left(\frac{100 \text{ pCi/g U - nat}}{7.1 \text{ mrem/yr U - nat dose}} \right) \text{x } 38.1 \text{ mrem/yr radium benchmark dose}$$

$$\text{Uranium Limit} = 537 \text{ pCi/g U - nat}$$

$$\left(\frac{\text{Soil Uranium Concentration}}{\text{Soil Uranium Limit}} \right) + \left(\frac{\text{Soil Radium Concentration}}{\text{Soil Radium Limit}} \right) < 1$$

The U-nat limit is applied to soil cleanup with the Ra-226 limit using the unity rule. To determine whether an area exceeds the cleanup standards, the standards are applied according to the following formula:

This approach will be used at the ISL site to determine the radiological impact on the environment from releases of source and byproduct materials.

6.4.1.3 Uranium Chemical Toxicity Assessment

The chemical toxicity effects from uranium exposure are evaluated by assuming the same exposure scenario as that used for the radiation dose assessment. In the benchmark dose assessment for the resident farmer scenario, it was assumed that the diet consisted of 25 percent of the meat, fruits, and vegetables grown at the site. No intake of contaminated food through the aquatic or milk pathways was considered probable. Also, the model showed that the contamination would not affect the groundwater quality. Therefore, the same model will be used in assessing the chemical toxicity. The intake from eating meat was shown to be negligible compared to the plant pathway and therefore is not shown here. This is confirmed by the results of the RESRAD calculations shown in Attachment 3.1 of Appendix 6.4-A and the figures generated with RESRAD shown in Attachment 4.1 of Appendix 6.4-A.

The method and parameters for estimating the human intake of uranium from ingestion are taken from NUREG/CR-5512 Vol. 1 (NRC, 1992). The uptake of uranium in food is a product of the uranium concentration in soil and the soil-to-plant conversion factor. The annual intake in humans is then calculated by multiplying the annual consumption by the uranium concentration in the food. Since the soil-plant conversion factor is based on a dry weight, the annual consumption must be adjusted to a dry-weight basis by multiplying by the dry-weight to wet-weight ratio. Parameters for these calculations are given in Section 6.5.9 of the NUREG/CR-

5512 Vol. 1 (NRC, 1992). Table 6.4-1 provides the parameters used in these calculation and results for leafy vegetables, other vegetables, and fruit. Annual intakes of 14 kg/year and 97 kg/year were assumed for leafy vegetables and other vegetables and fruit, respectively. Consistent with Attachment 3.1 of Appendix 6.4-A dose calculations, it was assumed that 25 percent of the food was grown on the site. It was also assumed that the uranium concentration in the garden or orchard was 537 pCi/g. This corresponds to the uranium Benchmark Concentration for surface soils. Using a conversion factor for U-nat of 1 mg = 677 pCi, then 537 pCi/g is equivalent to 793 mg/kg. The human intake shown in the first column of Table 6.4-1 is equal to the product of the parameters given in the subsequent columns. Table 6.4-1 shows that the total annual uranium intake from all food sources from the site is 52.4 mg/yr.

The two-compartment model of uranium toxicity in the kidney from oral ingestion was used (ICRP, 1995) to predict the burden of uranium in the kidney following chronic uranium ingestion. This model allows for the distribution of the two forms of uranium in the blood, and consists of a kidney with two compartments, as well as several other compartments for uranium distribution, storage and elimination including the skeleton, liver, red blood cells (macrophages) and other soft tissues.

Table 6.4-1: Annual Intake of Uranium from Ingestion

Food Source	Human Intake (mg/yr)	Soil Concentration (mg/kg)	Soil to Plant Ratio (mg/kg plant to mg/kg soil)	Annual Consumption (kg)	Dry Weight Wet Weight Ratio
Leafy Vegetables	9.4	793	1.7E-2	3.5	0.2
Other Vegetables	36.1	793	1.4E-2	13	0.25
Fruit	6.9	793	4.0E-3	12	0.18
Total	52.4				

The total burden to the kidney is the sum of the two compartments. The mathematical representation for the kidney burden of uranium at steady state can be derived as follows (ICRP, 1995):

$$Q_P = \frac{IR \times f_1}{\lambda_P \left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pk} - f_{pk1}\right)}$$

Where:

Q_P = uranium burden in the plasma, µg

IR = dietary consumption rate, mg U/d

f_1 = fractional transfer of uranium from GI tract to blood, unitless

f_{ps} = fractional transfer of uranium from plasma to skeleton, unitless

f_{pr} = fractional transfer of uranium from plasma to red blood cells, unitless

f_{pl} = fractional transfer of uranium from plasma to liver, unitless

f_{pt} = fractional transfer of uranium from plasma to soft tissue, unitless

f_{pk1} = fractional transfer of uranium from plasma to kidney, compartment 1, unitless

λ_p = biological retention constant in the plasma, d^{-1}

The burden in kidney compartment 1 is:

$$Q_{k1} = \lambda_P \times Q_P \times \frac{f_{pk1}}{\lambda_{k1}}$$

Where:

Q_{k1} = uranium burden in kidney compartment 1, mg

λ_{k1} = biological retention constant of uranium in kidney compartment 1, d^{-1}

Similarly, for compartment 2 in the kidney, the burden is:

$$Q_{k2} = \lambda_P \times Q_P \times \frac{f_{pk2}}{\lambda_{k2}}$$

Where:

Q_{k2} = uranium burden in kidney compartment 2, μg;

λ_{k2} = biological retention constant of uranium in kidney compartment 2, d^{-1};

f_{pk2} = fractional transfer of uranium from plasma to kidney compartment 2, unitless.

The total burden to the kidney is then the sum of the two compartments is:

$$Q_{k1} + Q_{k2} = \frac{IR \times f_1}{\left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pt} - f_{pk1}\right)} \times \left(\frac{f_{pk1}}{\lambda_{k1}} + \frac{f_{pk2}}{\lambda_{k2}}\right)$$

The parameter input values for the two-compartment kidney model include the daily intake of uranium estimated for residents at this site, and the ICRP69 values recommended by the ICRP as listed below (ICRP, 1995). The daily uranium intake rate was estimated to be 0.14 mg/day (52.4 mg/year) from ingestion while residing at this site.

IR = 0.14 mg/day

f_1 = 0.02

f_{ps} = 0.105

f_{pr} = 0.007

f_{pl} = 0.0105

f_{pt} = 0.347

f_{pk1} = 0.00035

f_{pk2} = 0.084

λ_{k1} = ln(2)/(5 yrs*365 days/yr)

λ_{k2} = ln(2)/7 days

where ln(2) = 0.693...

Given a daily uranium intake of 0.14 mg/day at this site and the above equation, the calculated uranium in the kidneys is 0.0093 mg U, or a concentration of 0.032 μg U/g kidney. This is 3.2 percent of the 1.0 μg U/g value that has generally been understood to protect the kidney from the toxic effects of uranium. Some researchers have suggested that mild effects may be observable at levels as low as 0.1 μg U/g of kidney tissue. Using 0.1 μg U/g as a criterion, then the intake is 32 percent of the level where mild effects may be observable.

The EPA evaluated the chemical toxicity data and found that mild proteinuria has been observed at drinking water levels between 20 and 100 μg/liter. Assuming water intake of 2 liters/day, this corresponds to an intake of 0.04 to 0.2 mg/day. Using animal data and a conservative factor of 100, the EPA arrived at a 30 μg/liter limit for use as a National Primary Drinking Water Standard (Federal Register/Vol.65, No.236/ December 7, 2000). This is equivalent to an intake of 0.06 mg/day for the average individual. Naturally, since large diverse populations are potentially exposed to drinking water sources regulated using these standards, the EPA is very conservative in developing limits.

This analysis indicates that a soil limit of 537 pCi/g of U-nat would result in an intake of approximately 0.14 mg/day. Using the most conservative daily limit corresponding to the National Primary Drinking Water standard, a soil limit of 230 pCi/g corresponds to the EPA intake limit from drinking water with a uranium concentration of 0.06 mg/day. Therefore exposure to soils containing 230 pCi/g of natural uranium should not result in chemical toxicity effects. Since the roots of a fruit tree would penetrate to a considerable depth, limiting subsurface uranium concentrations to 230 pCi/g will be considered.

The ALARA principle requires an evaluation of, considering a cost benefit analysis and socio-economic impacts, the practicality of lowering established or derived soil cleanup levels. For gamma-emitting radionuclides, the cost and potential impacts becomes excessively high as soil concentrations, thus the gamma emission rates, become indistinguishable from background.

Cleanup of uranium mill sites has demonstrated that conservatively derived gamma action levels coupled with appropriate field survey and sampling procedures result in radium-226 soil concentrations near background levels. The presents of radium-226 and natural uranium in a mixture will tend to drive the cleanup to lower radium-226 concentrations. The ALARA principle is met by choosing conservatively derived gamma actions levels, thus no ALARA goals for radium-226 need to be established.

Powertech (USA) proposes and ALARA goal of limiting the natural uranium concentration in the top 15 cm soil layer to 150 pCi/g averaged over the impacted areas. Subsurface soil (greater than 15 cm) natural uranium concentrations should be limited to 230 pCi/g averaged over the impacted area based on chemical toxicity.

6.4.2 Excavation Control Monitoring

The purpose of excavation control monitoring will be to guide the removal of contaminated material to the point where it is highly probable that an area meets the cleanup criteria.

Gamma surveys will be relied on to guide soil remediation efforts. The surveys will be done over the extents of affected and buffer areas. The surveys will identify soil contamination that exceeds the cleanup criteria and will be used to guide the cleanup efforts. After cleanup, the surveys will be used, in conjunction with surface soil sample analyses, to verify cleanup to the site cleanup criteria.

Two methods are proposed for conducting site gamma surveys, the first is the use of the GPS-based radiological survey system and the second is the use of the equivalent conventional method using a Ludlum 2221 rate-meter/scaler and Model 44-10 detector.

Since the methods differ only by data recording and management, there will be no apparent differences in the accuracy of the results.

Gamma Action Level

A gamma action level, defined as a gamma count-rate level corresponding to the soil cleanup criterion, is used in the interpretation of the data. Normally the action level is conservatively developed to allow only a five percent error rate of exceeding the cleanup criteria at the

95 percent confidence level. The gamma action level may change as contaminated soil and associated gamma "shine" is removed. Thus, several action levels may be established. A particular action level will correspond to a gamma-ray count rate that conservatively predicts that the radium-226 in soil may be above the cleanup criterion. In addition, one action level will be required where radium-226 is the principal contaminant, such as in the well fields. Another action level will be required for areas affected by uranium releases, such as in plant areas.

The methods to determine gamma action levels will be determined prior to decommissioning.

For areas exhibiting contamination below the top 6 inches, excavation control monitoring will be done using the same detector deployed to determine the action level. Subsurface excavation control monitoring will consider the appropriate action level, adjusting for geometry factors.

After the remediation, the area will be resurveyed and the new data added to the database. Remediation will continue in areas not meeting action levels. This iterative procedure will be applied until all areas are determined to meet the action levels.

6.4.3 Surface Soil Cleanup Verification and Sampling Plans

In general, a combination of 10 CFR 40 Appendix A, MARSSIM-like, or other applicable approaches, including considerations of ALARA and the chemical toxicity of uranium, will be used for verification surveys (final status surveys) using the Data Quality Objectives (DQOs) established in a QAPP. Compliance with cleanup criteria will be evaluated in terms of soil concentrations, which will be supplemented by field surveys employing gamma-ray measurements. A final gamma survey of the affected area and buffer zone will be performed using the GPS-based equipment or conventional equipment.

6.4.4 Quality Assurance

Powertech (USA) will prepare a QAPP that establishes the quality assurance and control measures for field measurement, sample collection, and laboratory analysis for all decommissioning activities. The QAPP will also establish performance criteria for field and laboratory data precision, accuracy, completeness, and representativeness. The QAPP will contain recommendations in NRC Regulatory Guide 8.15, *Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)-Effluent Streams and the Environment* (NRC, 2007).

Powertech (USA) management will check all aspects of data collection and input to verify that procedures are being followed. The collection and handling of samples from the plant decommissioning, soil cleanup, and other radiological cleanup areas will be reviewed and approved by management. Laboratory results for these samples will be evaluated and validated to requirements in the QAPP. Other aspects of the reclamation including adherence to the SOPs and adherence to the decommissioning plan will be evaluated periodically by Powertech (USA) management. The construction process will be monitored to confirm that appropriate physical and radiological safety procedures are followed. Excavation processes will be monitored to ensure that contaminated materials are not handled carelessly and that any spillage is collected and contained. The conveyance of contaminated materials through the site, e.g., to stockpiling areas, will be monitored to prevent dispersal of these materials in the environment. Construction and sampling activities will be documented and reviewed throughout the reclamation process.

6.5 Decommissioning Health Physics and Radiation Safety

The health physics and radiation safety program for decommissioning will ensure that occupational radiation exposure levels will be kept as low as reasonably achievable during decommissioning. The Radiation Safety Officer, Radiation Safety Technician or designee will be on site during any decommissioning activities where a potential radiation exposure hazard exists. In general, the radiation safety program discussed in Section 5 will be used as the basis for development of the decommissioning health physics program. Health physics surveys conducted during decommissioning will be guided by applicable sections of Regulatory Guide 8.30 or other applicable standards at the time.

6.5.1 Records and Reporting Procedures

At the conclusion of site decommissioning and surface reclamation, a report containing all applicable documentation will be submitted to the NRC. Records of all contaminated materials transported to a licensed disposal site will be maintained for five years, or as otherwise required by applicable regulations at the time of decommissioning.

6.6 Financial Assurance

In compliance 10 CFR Part 40 Appendix A criteria and NUREG-1569 and 1757, Powertech (USA) will maintain financial assurance instruments to cover the cost of reclamation including the costs of groundwater restoration, the cost of decommissioning, dismantling and disposal of all buildings and other facilities, and the reclamation and revegetation of affected areas for the project. Table 6.6-1 and Table 6.6-2 provide summaries of closure cost estimates for the land application and waste disposal well options, respectively. Detailed cost tables are provided in Appendix 6.6-A. In accordance with NRC requirements, an updated Annual Surety Estimate Revision will be submitted each year adjusting the surety instrument to reflect existing operations and those planned for construction or operation in the following year. After review and approval of the Annual Surety Estimate Revision by the NRC, Powertech (USA) will revise the surety instrument to reflect the updated amount.

Table 6.6-1: Summary of Closure Costs for Land Application

No.	Cost Item for Proposed Action Land Application Only	Cost
1	Water Treatment Equipment	2,660,000
2	Groundwater Restoration Cost	2,398,000
3	Well Closure	706,000
4	Mobilization and Site Preparation	25,000
5	Demolition and Disposal of 11e(2)	1,489,000
6	Plant Equipment Transferred	243,000
7	Demolition with Disposal in Landfill	2,790,000
8	Other Reclamation	2,114,000
9	Contingency at 15%	1,664,000
	Total Restoration and Reclamation Cost	**14,089,000**

Table 6.6-2: Summary of Closure Costs for Waste Disposal Well

No.	Cost Item Proposed Action Waste Disposal Well Only	Cost
1	Water Treatment Equipment	-
2	Groundwater Restoration Cost	1,877,000
3	Well Closure	490,000
4	Decommissioning Labor	706,000
5	Mobilization and Site Preparation	25,000
6	Demolition and Disposal of 11e(2)	702,000
7	Plant Equipment Transferred	239,000
8	Demolition with Disposal in Landfill	1,228,000
9	Other Reclamation	915,000
10	Contingency at 15%	927,000
	Total Restoration and Reclamation Cost	**7,109,000**

6.7 References

ANL, 1993, "*Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil*", Environmental Assessment Division, Argonne National Laboratory, ANL/EAIS-8, Argonne, Illinois.

Code of Federal Regulations, 10 CFR 40, "Appendix A, Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content".

ERG, Inc., 2008, "*Radium Benchmark Dose Assessment for Dewey-Burdock Uranium In-situ Recovery Facility*", Environmental Restoration Group, Inc., Albuquerque, NM.

ICRP, 1995, ICRP Publication 69 – "*Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 3 Ingestion Dose Coefficients*", International Commission on Radiation Protection, Tarrytown, New York.

NRC (1983), "*Aquifer Restoration at In-Situ Leach Uranium Mines: Evidence for Natural Restoration Processes*", NUREG/CR-3136, Washington DC: USNRC. April 1983.

NRC, 1992, "*Residual Radioactive Contamination from Decommissioning*," U.S. Nuclear Regulatory Commission, NUREG/CRR-5512 (PNL-7994) Vol. 1, Washington, DC.

NRC, 2003, "*Standard Review Plan for In situ Leach Uranium Extraction License Applications*", Division of Fuel Cycle Safety and Safeguards, Office of Nuclear Material Safety and Safeguards, U. S. Nuclear Regulatory Commission, NUREG-1569, Washington, DC.

NRCS, 2007, "*2003 Annual National Resources Inventory*", Natural Resources Conservation Service, U.S. Department of Agriculture, Washington, DC.

TVA, 1979, "*Draft Environmental Statement – Edgemont Uranium Mine*", Tennessee Valley Authority, Knoxville, Tennessee.

USGS, 2004, "*Estimated Use of Water in the United States in 2000*", U.S. Geological Survey, U.S. Department of the Interior, USGS Circular 1268, Reston, Virginia.

7.0 Potential Environmental Effects

This section discusses potential direct and indirect environmental impacts (effects) that may be temporary (short term) or permanent (long term) in nature, and are associated with the construction and operation of the Dewey-Burdock Project. After a complete site specific analysis of the potential impacts of the Proposed Action Powertech (USA) concludes that such potential impacts fall within the scope of the analysis and conclusions in NUREG-1910 regarding the South Dakota-Nebraska Region.

7.1 Potential Environmental Effects of the Site Preparation and Construction

Site preparation and construction activities associated with the project facilities include site characterization, drilling wells, clearing and grading related to building and road construction, installation of pipelines, and construction of evaporation ponds. Construction at an ISL site is phased and iterative as new well fields are developed throughout the life of the project.

7.1.1 Potential Air Quality Effects of Construction

ISL facilities typically do not affect air quality drastically (NUREG-1910, 2008). The potential impacts due to construction are classified as SMALL if (1) the gaseous emissions are within regulatory limits; (2) the air quality in the region of influence is in compliance with the National Ambient Air Quality Standards (NAAQS); and (3) the facility is not classified as a major source according to the New Source Review or operating permit programs. Due to the isolated location (13 miles northwest of Edgemont) and the atmospheric conditions of the PAA, the potential cumulative air quality impacts will be negligible. The generation of dust and emissions will be limited to the brief construction phase.

The construction phase of ISL projects and facilities generally produces non-radiological gaseous emissions including fugitive dust and combustion emissions. Diesel emissions from construction equipment comprise the majority of the combustion emissions and are considered to be small, short-term effects.

Potential air quality impacts during construction activities at the project will include emissions from heavy equipment, vehicle and drill rig exhaust, dust from traffic, and dust from disturbing soil during drilling and ground-clearing activities. Mobile sources of emissions will be diesel engines on the drill rigs and diesel water trucks. All vehicles on-site will meet EPA and DOT vehicle emission standards.

The greatest amount of dust will be generated from vehicular traffic on the unpaved roads; therefore, speed limits will be imposed for employee vehicles and transport trucks in order to mitigate the amount of dust generated from unpaved roads. Employee car pooling will be encouraged, which will keep the vehicular traffic at a minimum. Temporarily disturbed areas will be reseeded and restored as soon as possible to minimize erosion of soil and fugitive dust emissions.

7.1.2 Potential Land Use Effects of Construction

Rangeland and pastureland are the primary land uses within the PAA and the surrounding 2 km review area. While, the Proposed Action site encompasses 10,580 acres, the land potentially disturbed by the Proposed Action will be approximately 68 acres (facilities, piping, ponds, well fields and roads) the year proceeding operation. The disturbed area during the life of the project (production to restoration) is estimated to increase over time to a maximum of 108 acres. If the maximum area for land application of treated wastewater is included in the footprint of the Proposed Action, then approximately a maximum additional 355 acres would be affected by the Proposed Action for most of the project life. The maximum potential disturbance at any given time is expected to be 463 acres.

Under the proposed action, this land will be temporarily converted from its previous use as rangeland and pastureland to ISL use on a "phased" basis. The land will likely experience an increase in human activity also contributing to further land disturbance. The disturbance associated with drilling and pipeline and facility construction will be limited and temporary as vegetation will be re-established through concurrent reclamation. The construction of new access and secondary roads will be minimized to the extent possible.

Recreational use within the project boundary is limited primarily to large game hunting. Within the PAA, hunting is currently open to the public on approximately 5,689 acres. Approximately 240 acres are owned by the Bureau of Land Management (BLM); the South Dakota Game Fish and Parks (SDGF&P) lease around 3,069 acres annually of privately owned land and currently designate this acreage as walk-in hunting areas. Prior to commencement of operations, all hunting will be prohibited within the Permit Boundary.

Additional potential land use impacts could include the disruption to livestock grazing within the PAA. This disturbance will be temporary in the area until the area is released for unrestricted use. Potential impacts include surface soil contamination from leaks or spills in well fields or from pipelines, but site reclamation will ensure that such impacts are temporary and eliminated prior to site closure.

7.1.3 Potential Surface Water Effects from Construction

Construction activities within the well fields, along the pipeline courses and roads, and at the process plant have the potential to increase the sediment yield of the disturbed areas. The potential impacts from increased sedimentation will be minimal because of the short-term nature of the disturbance (areas will be concurrently reclaimed) and the area of disturbance is small compared to the total drainage basin of Angostura Reservoir (total area 7143 mi^2) and because of the lack of dependable surface water supplies (DENR, 2007). A slight increase in sediment yields and total runoff can be expected during final reclamation; however, well field decommissioning and reclamation activities via best management practices and mitigation measures utilized throughout the life of the project will help to reduce the potential impacts. No direct disturbance to any wetlands or water sources is planned at this time. If, in the future, the proposed action should involve an impact to a jurisdictional wetland area or water source, the appropriate actions will be taken in accordance with Section 404 of the Clean Water Act and ACE regulations.

According to NUREG-1910, "*Potential indirect impacts of ISL operations could include increased sediment deposition in streams, which could alter stream morphology and degrade the suitability of channel substrate for aquatic organisms. However, as stated previously, this issue is addressed by NPDES storm water requirements, and good management practices likely will minimize, if not eliminate, any such potential impacts*" (NUREG-1910, 2008). Indirect potential impacts to surface water will be limited to uncommon precipitation or runoff events (e.g., a flood event).

There were 20 potential wetland sites evaluated by the USACE; the determination rendered 4 of the 20 evaluated as Jurisdictional sites (see Appendix 7.1-A). Descriptions of the jurisdictional determination: Ephemeral Tributary to Beaver Creek, Ephemeral Tributary to Pass Creek, Pass Creek (NonRPW), Beaver Creek (Perennial RPW). Beaver Creek is the only perennial stream within the PAA and the rest of the natural water flow is ephemeral. Of the jurisdictional determinations within the PAA, potential impact is expected to be small and none are expected to experience direct impact from the pre-operational or operational activities. Erosion potential is present due to the possible construction of the wells near the drainage area; however, disturbance is expected to be mild and short-term.

An old mine pit located at Waypoint 37 was determined to be a non-wetland area. Although surface water was present, there was no hydrophytic vegetation or hydric soils. This old mine pit is also located along a disturbance area. The concentration of old mine pits along the eastern edge of the permit area contained small PUB wetlands (0.175 acres) that are a product of the old mine pits, that could be directly impacted by the disturbance areas located along the old mine pits.

ISL operations do not involve the consumption of surface waters. Nor do the operations proposed require a long- term discharge to surface waters. For these reasons, no significant impacts to surface water quantity and use are anticipated.

7.1.3.1 Potential Surface Water Effects from Sedimentation

Increased sedimentation of water bodies due to construction activities may be a concern at the site. Land clearing for construction of roads, well pads, pipelines, and other various structures may result in soil exposure to water and wind erosion. Soil is often compacted by vehicle use during various construction activities, resulting in decreased soil permeability, and thus increased water runoff. The soil exposure and increased water runoff may cause sedimentation to be carried into surface water bodies.

7.1.4 Potential Population, Social, and Economic Effects of Construction

The construction phase of the project could result in moderate impacts to the local economy as a result of purchasing goods and services directly related to construction activities. Impacts to community services such as roads, housing, schools, and energy costs are expected to be minor or non-existent and temporary in duration.

For the construction phase of the project, an estimated 86 payroll workers will be engaged directly in construction activities. An estimated 176 additional non-payroll positions will be created in Custer and Fall River Counties as a result of construction activities and non-payroll capital expenditures incurred by the project.

7.1.5 Potential Noise Effects of Construction

Because of the remote location of the project site and lack of sensitive receptors, noise impacts are not expected to increase beyond ambient levels due to plant operations. Likewise, no detrimental off-site noise impacts are anticipated due to the increase in commuter and truck traffic volumes or from construction. Noise levels generated during operation of the ISL project are not expected to result in any significant impacts to violate any noise standards. Open rangeland and pastureland are the primary land uses within the PAA and the surrounding 2 km area.

Outdoor noise levels at the nearest off-site receptors will be well within the 55-dBA daytime guideline, to protect against activity interference and annoyance (EPA, 1978). Noise levels during well field construction should cause no off-site impacts, since the PAA is not in close proximity to off-site receptors and will occur only during daylight hours.

7.2 Potential Environmental Effects of Operations

This section describes the environmental effects of operation at the ISL project. Operations activities include:

- Ongoing well field construction activities including well drilling and construction, construction of access roads, installation of pipelines and utilities, and headerhouse construction
- CPP and well field production operations
- Groundwater restoration activities associated with well field decommissioning
- Final site reclamation activities

Potential environmental concerns from the operation of the project are addressed in the following sections and include: air quality impacts, land use impacts, geological and soil impacts, impacts to cultural resources, water quality impacts, and ecological impacts.

7.2.1 Potential Air Quality Effects of Operations

The project site is not expected to be a major point source emitter and is not expected to be classified as a major source of emissions. New emissions are introduced during the operation phase of an ISL project including the release of pressurized vapor from well field pipelines. Other additional possible emissions include those that may be emitted during resin transfer or elution. Naturally occurring radon gas may also be released when the well pipeline system is vented. This is the greatest air quality concern of ISL operations. Radon gas release is discussed further in Section 4.1.1. Non-radiological emissions from pipeline system venting, resin transfer, and elution are expected to have a minimal impact on air quality at the site due to the low volume of effluent produced and the rapid dispersion of the emissions.

Yellowcake drying operations can also produce gaseous effluents, with the greatest concern being the release of uranium particles. As discussed in Section 3.2.5, the yellowcake will be dried at approximately 450°F in a rotary vacuum drying process. The off gases generated during the drying cycle are filtered through a baghouse, which is located on the top of the dryer, to remove particles down to approximately 1 micron in size. The gases are then cooled and scrubbed in a surface condenser to further remove the smaller size fraction particulates and the water vapor during the drying process. The potential impacts related to yellowcake drying are expected to be small due to the required filtration systems put in place.

Fugitive dust and emissions from on-site traffic associated with operations and maintenance will also be expected, but will amount to less than was produced during construction of the facilities at the site, so impacts are expected to be small.

7.2.2 Potential Land Use Effects of Operations

The primary land use within the PAA is rangeland. Operation of the project facilities will restrict the use of land as rangeland for the duration of the project. Following production and restoration, the PAA will be returned to rangeland use.

The Proposed Action could temporarily impact recreational use, limited primarily to large game hunting, within the project boundary., Within the PAA, hunting is currently open to the public on approximately 5,689 acres (2,302 ha). Approximately 240 acres (97.12) are owned by the Bureau of Land Management (BLM); the South Dakota Game Fish and Parks (SDGFP) lease around 3,069 acres (1,241 ha) annually of privately owned land and currently designate this acreage as walk-in hunting areas. Prior to commencement of operations, all hunting will be prohibited within the Permit Boundary.

Additional potential land use impacts could include the disruption to livestock grazing within the PAA. Approximately 9.46 acres (3.828 ha) will be removed from grazing on the BLM land. This disturbance will be temporary in the area until the area is released for unrestricted use. Potential impacts include surface soil contamination from leaks or spills in well fields or from pipelines, but site reclamation will ensure that such impacts are temporary and small prior to site closure. Given the relatively small size of the area impacted by operations, the exclusion of grazing from this area over the course of the project is expected to have minimal impact on local livestock production.

7.2.3 Potential Geologic and Soil Effects of Operations

The following section discusses the potential geological and soil impacts of operations at the project.

7.2.3.1 Potential Geologic Effects of Operations

Potential geologic impacts from the project are expected to be negligible or non-existent. The project is not expected to have a significant effect on ground subsidence or matrix compression because the net withdrawal of fluid (bleed) from the extraction zone is generally on the order of 3 percent or less, and the ISL process does not remove matrix material or structure. After restoration is complete, the groundwater levels are expected to return to pre-operational levels, and should therefore not have any significant effects on the quantity of groundwater.

Impacts are more likely to occur from other geologic factors such as earthquakes. As discussed in Section 2.6.6, the maximum magnitude earthquake estimated for the PAA is a VII on the Modified Mercalli Scale, corresponding to a Richter magnitude of 6.1.

Due to the design of the project, no significant geologic impacts are anticipated, according to NUREG-1910.

7.2.3.2 Potential Soil Effects of Operations

There are two main drainage basins located in the PAA; each of the drainages have different soil types. The soil mapping unit descriptions are in Section 3.3. The Beaver Creek basin is composed of Haverson loam, and has 0-2 percent slopes throughout the drainage. The Cottonwood Gallery basin is composed of Barnum silt loam in the south half of the drainage and Barnum-Winetti complex, and has 0-6 percent slopes. The old mine pits were also classified as Barnum silt loam and Barnum-Winetti complex.

The ISL operation will disturb approximately 68 acres (27 ha) (facilities, piping, ponds, well fields and roads) in year one. Potential intermittent impacts include:

- Compaction
- Loss of productivity
- Loss of soil
- Salinity

- Soil contamination

These impacts could potentially occur via:

- Clearing vegetation
- Compaction
- Excavation
- Leveling
- Redistribution of soil
- Stockpiling

Severity of impacts to soil is dependent upon type of disturbance, duration of disturbance and quantity of acres disturbed. Construction and operation activities have the potential to compact soils. Soils most sensitive to compaction, clay loams, are not present within the Proposed Permit Area, however; due to the use of heavy machinery and high volume within certain area some soils have the potential for compaction. Compaction of the soil can lead to decreased infiltration thereby increasing runoff. Soils compacted during construction and operations will be restored (i.e., disced and reseeded) as soon as possible following use.

Based on the soil mapping unit descriptions, the hazard for wind and water erosion within the PAA varies from negligible to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Given the very fine and clayey texture of the surface horizons throughout the majority of the PAA, the soils are more susceptible to erosion from water than wind. See Table 2.6-7 for a summary of potential wind and water erosion hazards within the PAA.

During land application disposal, there could be potential impacts to the soil from elevated TDS and electrical conductivity (EC) values in the water (Table 4.2-6) to be used to irrigate crops and salt tolerant wheat grasses. Irrigation water quality is commonly assessed in terms of soluble salt content, percentage of sodium, boron, and bicarbonate contents. In the case of the water used for irrigation the soluble salts are on the order of 3,000 to 4,000 μS/cm at 25 °C. These levels pose low to moderate risk to the growth of moderately sensitive crops such as alfalfa and corn. The SAR levels are low and pose little risk to water erosion during the infiltration of rain or snowmelt. There could be some salt deposition at the surface, however maintaining maximum crop growth will reduce the possibility of undesirable species. During the irrigation season, water application rates will be determined to optimize both evaporation and crop production.

Table 7.2-1: SAR, ESP and RSC Calculations for Dewey and Burdock End-of-Production Ground Water Quality([a])

	Dewey					Burdock				
Constituent	(mg/L)	(meq/L)	ESP[(1)]	RSC[(2)]	SAR[(3)]	(mg/L)	(meq/L)	ESP[(1)]	RSC[(2)]	SAR[(3)]
CO_3	0.5	0.02				0.50	0.02			
HCO_3	25	0.41				25.00	0.41			
Cl	1,300	36.67				1,300	36.67			
SO_4	1,000	20.82				1,800	37.48			
Na	270	11.74				190	8.26			
Ca	730	36.43				970	48.40			
Mg	120	9.87	2.29	-45.87	2.44	220	18.09	0.85	-66.07	1.43
K	20	0.51				10	0.26			
Total Ion Bal.		0.54					0.29			
SAR (measured)	4.9					2.8				
pH (s.u.)	6.5-7.5					6.5-7.5				
TDS (mg/L)	4,500					4,500				
Elec. Cond. (µS/cm)	3,000					4,000				
As	0.01					0.01				
V	<10					6				

([a]) - Estimated by Powertech (USA) based on results of laboratory scale leach tests conducted on ore samples from the Fall River and Lakota sites, as well as from historical end-of-production water quality data from other ISL sites in Wyoming and Nebraska, with adjustments as necessary to account for planned post-production water treatment(s).

18. ESP = Exchangeable Sodium Percentage. Empirical relationship from Withers and Vipond (1980).

$$ESP = \frac{100(-0.0126 + 0.01475 * SAR)}{1 + (-0.0126 + 0.01475 * SAR)}$$

19. RSC = Residual Sodium Carbonate (meq/L) $RSC = ([CO_3] + [HCO_3]) - ([Ca] + [Mg])$

20. SAR = Sodium Adsorption Ratio $SAR = \frac{[Na]}{\sqrt{([Ca] + [Mg])/2}}$

Facility development could displace topsoil, which could adversely affect the structure and microbial activity of the soil. Loss of vegetation would expose soils and could result in a loss of organic matter in the soil. Excavation could cause mixing of soil layers and breakdown of the soil structure. Removal and stockpiling of soils for reclamation could result in mixing of soil profiles and loss of soil structure. Compaction of the soil could decrease pore space and cause a loss of soil structure as well. This could result in a reduction of natural soil productivity. Increased erosion and decreased soil productivity may cause a potential long-term declining trend in soil resources. Long-term impacts to soil productivity and stability could occur as a result of large-scale surface grading and leveling, until successful reclamation is accomplished. Reduction in soil fertility levels and reduced productivity could affect diversity of reestablished vegetative communities. Infiltration could be reduced, creating soil drought conditions. Vegetation could undergo physiological drought reactions (Lost Creek, 2007).

Overall, the potential environmental impacts to the soil within the PAA may be increased compared to areas outside the PAA but typically will not result from the ISL process itself, but rather from ancillary activities such as waste disposal and construction. In the past, ISL facilities adopt best construction practices to prevent or dramatically decrease erosion (NUREG-1910). Many facilities have been operated to minimize erosion and surface disturbance and then assiduously restored affected soils effectively leaving little impact on soils (NMA, 2007).

7.2.3.2.1 Monitoring Well Rings, Well Field and Associated Piping

The scale of monitoring well rings will have little impact on the amount of soil disturbance. Differences in disturbance to soil will depend on area of monitoring well ring and natural growth of vegetation within the specific well field. During construction of each well field, drilling activities will occur only on a small percentage of an ISL site at any one time (HRI, 1997a). The amount of land disturbed at any time typically will range from 100 to 400 acres (EPA 2007); however, some ISL sites may be larger or smaller. Disturbance associated with drilling and pipeline and facility installation normally will be limited, as the affected area can be reclaimed and reseeded in the same season. Vegetation normally will be re-established over these areas within 2 years (NMA, 2007).

Subsurface soils will be excavated and removed from their native location. Excavated soils (drill cuttings) are returned to mud pits as TENORM.

Movement of drilling and construction equipment and installation of wellheads, piping systems, and other facilities will disturb small areas of surface soil. Vehicle movement could cause compaction, rutting, and other disturbances to the surface soil and rocks. Depending on the intensity and duration of construction activities, compaction and erosion of surface soil could alter drainage and cause accelerated erosion and degradation of surrounding surface water resources. However, good management practices likely will minimize, if not eliminate, any such potential impacts (NMA, 2007).

7.2.3.2.2 Wastewater Retention Ponds

Only very shallow surface soils in the immediate area could be disturbed during construction of the waste retention ponds, though excavated soils from other parts of the site typically will be imported and used to construct the foundation and walls of the ponds. Surface soils in the area will be compacted from the overlying weight of the pond.

Movement of construction equipment could disturb small adjacent areas of surface soil, and vehicle movement to and within the construction site could cause compaction, rutting, and other disturbances to the surface soil and rocks. Depending on the intensity and duration of construction activities, compaction and erosion of surface soil could alter drainage and cause accelerated erosion and degradation of surrounding surface water resources. However, good management practices will likely minimize any such potential impacts (NMA, 2007).

Wastewater produced during operations typically will be handled in one or a combination of two ways: waste disposal well or land application. Storage ponds of suitable capacity will be needed for deep-injection well disposal and land application. Where such wells are not available, land application is the only disposal option. The size of the storage ponds required and the land impacts are significantly different depending on the method of disposal utilized.

7.2.3.2.3 WASTE DISPOSAL WELL

As deep-disposal wells are drilled, there will be disruption of soil, rock formation, and water flow processes; however, these potential impacts are minor and are similar to common drilling for water, oil and gas. EPA/state UIC regulations and permitting guidance require an evaluation of the seismic risk of a potential disposal well site, including evaluation of the potential pressure impacts to the injection zone. As such, current regulations are in place to ensure the seismic stability of the selected injection site. Changes caused by thermal (heat caused by drilling), chemical (possible reaction caused displaced chemicals during drilling), and mechanical alterations will be negligible and similar to most drilling projects. As the Class I or V UIC deep-disposal well permitting process is intended to ensure protection of USDWs, ISL solutions destined for deep-injection well disposal will require compliance with EPA/state UIC regulations and, as such, the potential impacts will be negligible (NMA, 2007).

7.2.3.2.4 WELL FIELDS

In addition, the injection of treated groundwater as part of uranium recovery or as part of restoration of the recovery zone is unlikely to cause changes in the underground environment except to restore the water quality consistent with baseline or other NRC approved limits and to reduce mobility of any residual radionuclides. Further, industry standard operating procedures, which are accepted by NRC and other regulating agencies for ISL operations, include a regional pump test prior to licensing, followed by more detailed pump tests after licensing for each individual area where uranium will be recovered prior to its production. Any potential variations in hydrogeology, due to disruption of soil or rock formation will be assessed and taken into account prior to commencing operations to ensure that operations will not impact adjacent, non-exempt drinking water resources in the region. Powertech (USA)'s well field designs are substantially similar if not identical to those assessed in NUREG-1910. As a result, the potential impacts on soils from well fields will be within the scope of NUREG-1910's analyses and conclusions.

7.2.4 Potential Archeological Resources Effects of Operations

As discussed in Section 2.4.1, a Level III Cultural Resources Evaluation was conducted in the PAA. Personnel from the Archaeology Laboratory, Augustana College (Augustana), Sioux Falls, South Dakota, conducted on-the-ground field investigations between April 17 and August 3, 2007.

Augustana documented 161 previously unrecorded archaeological sites and revisited 29 previously recorded sites during the current investigation. Expansion of site boundaries during the 2007 survey resulted in a number of previously recorded sites being combined into a single, larger site. Twenty-eight previously recorded sites were not relocated during the current investigation. Excepting a small foundation, the non relocated sites were previously documented as either prehistoric isolated finds or diffuse prehistoric artifact scatters.

Prehistoric sites account for approximately 87 percent of the total number of sites recorded. Historic sites comprise approximately 5 percent of total sites recorded, while multi-component sites (prehistoric/historic) comprise the remaining 8 percent. Ten of the sites documented have only prehistoric and historic components.

The small number of Euro American sites documented was not unanticipated given the peripheral nature of the PAA in relation to the Black Hills proper. The disparity existing between the number of historic and prehistoric sites observed in the PAA is also not unexpected; however, the sheer volume of sites documented in the area is noteworthy. The land evaluated as part of the Level III cultural resources evaluation has an average site density of approximately 1 site per 8.1 acres. Even greater site densities were reported in 2000 during the investigation of immediately adjacent land parcels for the Dacotah Cement/BLM land exchange [Winham et al., 2001]. This indicates that the proposed Permit Area is not unique, in regards to the number of documented sites, and is typical of the periphery of the Black Hills.

As construction of ISL facilities takes place any previously undetected historical or cultural resources will be reported to the proper agency. The site will be evaluated and released by the proper agency before construction continues within the specific area. The phased approach that Powertech (USA) proposes will increase the likelihood of safeguarding historical and/or cultural resources. Another example of phasing, with which Powertech (USA) agrees, is a license condition that requires cessation of any site activities and the conduct of a cultural resources inventory if previously undetected historic or cultural properties are discovered during the development and construction of wellfields. Thus, "phasing" is an essential and integral component of *all aspects* of ISL uranium recovery projects (NMA, 2007).

7.2.4.1 Potential Visual and Scenic Resources Effects

Short-term and temporary impacts to the visual resources produced during construction could come from the addition of access roads, electrical distribution lines, header houses as well as drilling. Temporary impacted areas will be reclaimed upon completion of construction and debris created during construction will be removed as soon as possible to limit the aerial extent affected during construction.

The sources of potential long-term impacts to the visual resources will be the presence of the CPP, wellhead covers, access roads, a pipeline, holding ponds, and several ancillary buildings. These potential long-term visual impacts will remain present until the completion of restoration and reclamation, which will efface the presence of the visual impacts associated with the project.

The project could result in temporary, minor impacts to visual and scenic resources. The project will maintain the visual resource classification of the area. According to NUREG-1569, if the visual resource evaluation rating is 19 or less, no further evaluation is required. Based on the visual resource inventory conducted in June 2008, the total score of the two Scenic Quality

Rating Units within the Proposed License Area were 11 and 13; therefore, no further evaluation of the existing scenic resources or future changes to the scenic resources of the area due to the proposed project will be required.

To minimize potential impacts to visual and scenic resources, building materials and paint will be selected that complement the natural environment, according to BLM guidelines. Construction and placement of structures will take into consideration the topography in order to conceal wellheads, plant facilities, and roads from public vantage points. In order to mitigate the visual impacts of roads constructed, the topography that the road follows as well as the area of disturbance will be considered.

7.2.5 Potential Groundwater Effects on Operations

Consumption of groundwater and short-and long-term changes to groundwater are some of the potential groundwater impacts related to the operation of an ISL uranium operation.

7.2.5.1 Potential Groundwater Consumption

The majority of groundwater used in the ISL process will be treated and re-injected. Based on a median case of bleed of one percent of 2,000 gpm, or 20 gpm, the potential impacts from consumptive use of groundwater in the Fall River and Lakota aquifers are calculated below. There are separate calculations for the Fall River aquifer assuming pumping at the first proposed well field at the Dewey Site, and for the Lakota aquifer assuming pumping at the first proposed well field at the Burdock Site.

The potential impacts due to drawdown are calculated at the locations of the nearest wells outside the proposed Permit Boundary Area that are expected to remain active during the life of the Project

Drawdown Estimates

The Theis analytical solution includes the following assumptions (Driscoll, 1986):

- The aquifer is homogeneous and isotropic (same hydraulic conductivity everywhere)
- The aquifer is confined with uniform thickness and has infinite extent,
- No recharge to the aquifer occurs,

- The pumping well is fully penetrating and receives water from the full thickness of the formation,
- All water removed from the well comes from aquifer storage which is discharged instantaneously when the head is lowered,
- The piezometric surface is horizontal prior to pumping,
- The well is pumped at a constant rate,
- The pumping well diameter is small so well bore storage is negligible.

Possible barrier boundaries for the aquifer system include the respective outcrops of the Fall River and Lakota formations generally east and north of the property boundary, as well as the Dewey Fault to the north and east of the property boundary. However, the Dewey Fault is considered likely to terminate both the Fall River and Lakota aquifers at some distance to the west. Therefore, just the outcrop was assumed to be a straight line barrier boundary and modeled with "image" pumping wells (e.g. Fetter, 1988) having the same pumping rates as the production wells for the Fall River and Lakota aquifers. A spreadsheet developed by the U.S. Geological Survey to calculate drawdown according to the Theis equation (Halford and Kuniansky, 2002) was used to make the confined aquifer prediction calculations.

7.2.5.1.1 Drawdown Impact – Fall River Aquifer

The following is a summary of available aquifer parameter (transmissivity, storativity) determination in successful pumping tests.

- 1979 TVA tests at Burdock area (Bogg and Jenkins, 1980):
  - Formation transmissivity: 54 ft^2/day
  - Formation storativity: 1.4 x 10^{-5}
- 2008 Powertech (USA) tests at Dewey area (Knight Piésold, 2008):
  - Formation transmissivity: 255 ft^2/day
  - Formation storativity: 4.6 x 10^{-5}

To quantify the impact of the project on the Fall River Formation aquifer the following assumptions were used together with the range of aquifer parameters above:

- Production/restoration: 8 years
- Average net consumptive use: 20 gpm
- Location of pumping centroid: NW ¼ of Section 32, T6S, R1E
- Distance from pumping well to barrier boundary (Fall River outcrop): 14,610 ft
- Observation radius: 15,075 feet (nearest domestic well, Hydro ID = 18), SW ¼ of SW ¼ of Section 9, T7S, R1E
- Image well observation radius: 39,350 ft

For the 1979 TVA test parameters, the calculated drawdown at the nearest domestic well after 8 years of pumping at 20 gpm due to the pumping well alone is 26.8 feet. The calculated drawdown at the nearest domestic well due to the image well is 16.0 feet. Thus the estimated drawdown at the nearest domestic well is 42.8 feet after 8 years of continuous pumping at a rate of 20 gpm.

For the 2008 Powertech (USA) test parameters, the calculated drawdown at the nearest domestic well after 8 years of pumping at 20 gpm due to the pumping well alone is 6.1 feet. The calculated drawdown at the nearest domestic well due to the image well is 3.8 feet. Thus the estimated drawdown at the nearest domestic well is 9.9 feet after 8 years of continuous pumping at a rate of 20 gpm.

Therefore, based on available pumping test data, the range of possible drawdown estimates at the nearest domestic well, located 15,075 feet from the approximate center of pumping is 9.9 to 42.8 feet.

7.2.5.1.2 Drawdown Impact – Lakota Aquifer

The following is a summary of available aquifer parameter (transmissivity, storativity) determination in successful pumping tests.

- 1979 TVA tests at Burdock area (Bogg and Jenkins, 1980):
  - Formation transmissivity: 190 ft^2/day
  - Formation storativity: 1.8 x 10^{-4}

- 1982 TVA tests at Dewey area (Boggs, 1983):
  - Formation transmissivity: 590 ft^2/day
  - Formation storativity: 1.0 x 10^{-4}

- 2008 Powertech (USA) tests at Burdock area (Knight Piésold, 2008):
  - Formation transmissivity: 150 ft^2/day
  - Formation storativity: 1.2 x 10^{-4}

To quantify the impact of the Project on the Lakota Formation aquifer the following assumptions were used:

- Production/restoration: 8 years
- Average net consumptive use: 20 gpm
- Location of pumping centroid: SW ¼ of Section 11, T7S, R1E
- Distance from pumping well to barrier boundary (Lakota outcrop): 17,610 ft
- Observation radius: 10,915 feet (nearest domestic well, Hydro ID = 13) NE ¼ of NE ¼ of Section 4, T7S, R1E
- Image well observation radius: 36,170 ft

For the 1979 TVA test parameters, the calculated drawdown at the nearest domestic well after 8 years of pumping at 20 gpm due to the pumping well alone is 6.6 feet. The calculated drawdown at the nearest domestic well due to the image well is 2.9 feet. Thus the estimated drawdown at the nearest domestic well is 9.5 feet after 8 years of continuous pumping at a rate of 20 gpm.

For the 1982 TVA test parameters, the calculated drawdown at the nearest domestic well after 8 years of pumping at 20 gpm due to the pumping well alone is 3.0 feet. The calculated drawdown at the nearest domestic well due to the image well is 1.8 feet. Thus the estimated drawdown at the nearest domestic well is 4.9 feet after 8 years of continuous pumping at a rate of 20 gpm.

For the 2008 Powertech (USA) test parameters, the calculated drawdown at the nearest domestic well after 8 years of pumping at 20 gpm due to the pumping well alone is 8.7 feet. The calculated drawdown at the nearest domestic well due to the image well is 3.9 feet. Thus the estimated drawdown at the nearest domestic well is 12.6 feet after 8 years of continuous pumping at a rate of 20 gpm.

Therefore, based on available pumping test data, the range of possible drawdown estimates at the nearest domestic well, located 10,915 feet from the approximate center of pumping is 4.9 to 12.6 feet.

7.2.5.1.3 Monitoring

To assess the potential impacts from production and restoration operations on local groundwater, the background water levels in regional monitoring wells installed by Powertech (USA) will be monitored before production and as required during operations.

7.2.5.2 Potential Effects on Ore Zone Groundwater Quality

A potential environmental impact to groundwater as a result of ISL is the degradation of water quality in the ore zone within the well field areas. The impact, in and of itself, it is of limited, due to the fact that the groundwater quality is very poor prior to uranium ISL operations; this is due to the presence naturally occurring radionuclide levels that exceed EPA and/or state drinking water limits which serve as the base criteria for an UIC aquifer exemption and which can never serve as a USDW (HRI, 1997; NMA, 2007).

Powertech (USA) has proposed to use gaseous oxygen and carbon dioxide lixiviant. The interaction of the lixiviant with the mineral and chemical constituents of the aquifer results in an increase in trace elements and salinity during recovery due to a decrease in pH and IX. There is no conveyance of new constituent species from the recovery process into the groundwater. The recovery process may however raise levels of specific constituents that are present within the ore bearing zone and host aquifer pre-operations.

The reduced, insoluble form of uranium present in the ore zone pre-operations is solubilized as a direct result of oxidation via the ISL process when oxidized uranium is introduced to bicarbonate anions and become mobile for extraction. This is the most noticeable impact to the groundwater as a direct result of the ISL process. Although other trace constituents are mobilized during the ISL process, the concentrations of these constituents are dependent upon the specific mineralogy of each deposit and oxidation of trace elements for example: (1) iron sulfides would result in higher concentrations of sulfate; (2) ferroelite would result in higher selenium concentrations

(NMA, 2007). If these minerals are present in the respective ore zone it would result in a change in the pH from alkaline range down to a range in the neural scale, thus causing calcium carbonate to dissolve and result in another pH change moving upward to a more alkaline range due to the increase in calcium, chloride and carbonate.

During the IX above ground process, the uranium on the resin beads is exchanged for chloride. This chloride is introduced into the barren solution in the form of sodium chloride; therefore via the oxidation process which encourages pH adjustment and the IX process, the groundwater concentrations of constituents such as: calcium, sodium, carbonate, bicarbonate, sulfate, chloride, TDS, uranium, and pH are usually increased until the groundwater restoration is initiated within each well field (NMA, 2007).

7.2.5.3 Potential Groundwater Quality Effects from Leach Fluid Excursions

Leach fluid excursions have the potential to contaminate adjacent aquifers with radioactive and trace elements that have been mobilized during the ISL process. There are two types of excursions: vertical and horizontal. A vertical excursion is movement of solution into overlying or underlying aquifers. A horizontal excursion is a lateral movement of leach fluids outside the production zone of the orebody aquifer.

Vertical excursions can be caused by vertical hydraulic head gradients between the production aquifer and the underlying and overlying aquifers. These head gradients can be caused by potential increases in pumping from either the underlying or overlying aquifers for water supply in the vicinity of the ISL facility. Discontinuities in the thickness and spatial heterogeneities in the vertical hydraulic conductivity of confining units could also lead to vertical movement of solutions and excursions.

Another potential source of vertical excursions is potential well integrity failures during ISL operations. Inadequate construction, degradation, or accidental rupture of well casings above or below the uranium-bearing aquifer could allow lixiviant to travel from the well bore into the surrounding aquifer. Deep monitoring wells drilled through the production aquifer and confining units that penetrate aquitards could potentially create pathways for vertical excursions as well.

During normal ISL operations, inward hydraulic gradients are maintained by production bleed such that groundwater flow is towards the production zone from the edges of the well field. This inward gradient helps minimize the chance of a horizontal excursion occurring. The potential impact of a horizontal excursion could be significant should a large volume of contaminated water leave the production zone and move downgradient within the production aquifer to a zone used for water production. To reduce the likelihood and minimize the consequences of potential horizontal excursions, a ring of monitoring wells will be installed within and encircling the production zone to enable early detection of excursions. If an excursion is detected corrective actions will be taken and the well will be placed on a more frequent monitoring schedule until the well is found to no longer be in excursion.

7.2.5.4 Potential Groundwater Effects from Spills

Types of spills that could potentially impact groundwater during operations include: a leak in a storage pond, a release of pregnant and/or barren leach fluid, a release of injection or production solutions from associated piping, spills and potential well rupture. Potential impacts of contamination to shallow aquifers and surrounding soils may result from one or a combination of these types of spills. The likelihood of spills is minimized by way of rigorous safety training, and employing all necessary preventative procedures such as maintaining injection pressures below casing and formation rupture pressures, monitoring pressure in the header houses with instrumentation equipped with alarms and interlocks for early warning and maintaining operating pressures so as to minimize the likelihood for potential impacts to shallow

7.2.5.5 Potential Groundwater Effects from Land Application

Land application of treated wastewater could potentially cause radiological or other constituents, such as Selenium or other metals, to accumulate in soils or infiltrate into shallow aquifers. NRC and state release limits for land application of treated wastewater are expected to mitigate the potential effects of land application of treated wastewater on shallow aquifers.

Data from test pits 1, 2 and 5 were used to develop the soil profile used in the SPAW modeling for the Dewey site. The logs for these test pits indicated that bedrock was encountered at depths of 9 feet, 11 feet, and 8.5 feet respectively below the ground surface. The composite soil profile used to model the soil at the Dewey site had a total depth of 9.83 feet. The results of the SPAW modeling indicated that the soil moisture content at the base of this soil profile was less than field capacity for all cases that were modeled (28 15-year simulations) and that there was no percolation beyond the base of the soil profile. Therefore, it is assumed that there would be no lateral movement of water along the bedrock surface, and no vertical movement of water into the bedrock, and therefore no leaching of trace elements beyond the base of the soil profile.

Data from test pits 8, 9 and 10 were used to develop the soil profile used in the SPAW modeling for the Burdock site. The logs for these test pits indicated that bedrock was encountered at depths of 7 feet and 5 feet below the ground surface in test pits 8 and 9. Test pit 10 was excavated to a total depth of 12 feet, with a clayey silt layer from 2 feet to 12 feet below the ground surface. The composite soil profile used to model the soil at Burdock had a total depth of 8 feet. The results of the SPAW modeling indicated that the soil moisture content at the base of this soil profile was also less than field capacity for all cases that were modeled (28 15-year simulations) and that there was no percolation beyond the base of the soil profile. Again it is assumed that no lateral movement of water would occur along the bedrock surface, and that water would not move vertically into the bedrock, and therefore there would be no leaching of trace elements beyond the base of the soil profile.

Based on the above information, there will be no migration pathway of licensed material to groundwater beneath the land application pivot sites, thereby eliminating any potential of exposure and risk to human health and the environment.

7.2.6 Potential Surface Water Effects

Construction activities within the well fields, along the pipeline courses and roads, and at the process plant have the potential to increase the sediment yield of the disturbed areas. However, due to the relatively small size of these disturbances compared to the overall area and to the size of the watersheds, the increase is expected to be minimal. A slight increase in sediment yields and total runoff can be expected during final reclamation, however well field decommissioning and reclamation activities throughout the life of the project will help to reduce this increase.

In areas where surface structures including well fields and associated structures, access roads, office buildings, pipelines, facilities and other structures associated with ISL production and processing could affect surface water drainage patterns, diversion ditches and culverts will be used to minimize erosion and control runoff.

7.2.6.1 Potential Surface Waters and Wetlands

Powertech (USA) plans to construct several well fields atop the multiple disturbance areas located throughout the permit area. Process facilities are planned to be located adjacent to the uranium rollfront areas.

In the northwest section of the PAA the ore bodies lie to the northeast of Beaver Creek, the wetlands along Beaver Creek will not be directly impacted by the disturbance areas. Erosion potential is present due to the construction of the wells near the drainage; however, disturbance is short-term.

An old mine pit located at Waypoint 37 was determined to be a non-wetland area. Although surface water was present, there was no hydrophytic vegetation or hydric soils. This old mine pit is also located along a disturbance area. The concentration of old mine pits along the eastern edge of the permit area contained small PUB wetlands (0.175 acres) that are a product of the old mine pits. The wetlands associated with old mine pits are not planned to be disturbed.

The remaining disturbance areas in the PAA are located near a few small wetlands. These wetlands are likely not to have direct impacts from the wellfields presence but there may be indirect impacts due to the construction of the well fields.

Construction, operation, or reclamation activities, which cause disturbance or impacts to jurisdictional wetlands on the proposed Dewey-Burdock Project, will be performed in accordance with appropriate Nationwide Permits, if applicable. Nationwide Permit (NWP) 44 non-coal mining activities, which requires Pre-construction Notification (PCN) for all activities, NWP 12 utility line activities, which requires a PCN for an area where a section 10 permit is required, discharges that result in the loss of >1/10 acre, and NWP 14 linear transportation projects, which requires a PCN for 1/2 acre in non-tidal waters. NWP 44 has an acreage limit of half an acre for Waters of the United States (WoUS), NWP 12 and 14 also has a half an acre disturbance limit. Impacts to Other Waters of the United States (OWUS) are not considered under the acreage limit. (Federal Register V. 72, No. 47/ Monday, March 12, 2007 Notices) The wetlands found along Beaver Creek are recommended to be jurisdictional since Beaver Creek connects to the Cheyenne River which is a significant nexus. All other wetlands presented in this study are recommended to be non-jurisdictional since the wetlands are all isolated and do not support interstate commerce.

7.2.6.1.1 Wetland Survey Conclusions

The majority of the wetlands in the PAA fall within Beaver Creek, the remaining wetlands are dispersed throughout the PAA as small depressions and ponds, old mine pits, and an old open flowing well. The wetlands within the old mine pits are not planned to be disturbed and these areas are likely to be excluded from the disturbance areas. The remaining wetlands in the PAA are likely not to suffer a direct impact due to the construction of the well fields. There may be some minimal indirect effects to a few of the small depressional wetlands.

The PAA had 14.199 acres of wetland channel, 2.338 acres of isolated PEM, PEMC, PABJh, and PUSA ponds; 5.248 acres of PUB isolated depressions, 2.706 acres of PUS isolated depressions, and 10.623 acres of old mine pits classified as PUB, PEM, or OW. Wetlands found along Beaver Creek totaled 13.376 acres of wetland channel. These wetlands found along Beaver Creek are recommended to be jurisdictional because Beaver Creek connects to a significant nexus, the Cheyenne River. The remaining wetlands are recommended to be non-jurisdictional as they are isolated and do not connect to a jurisdictional source.

Final determination of jurisdictional decision lies within the U.S. Army Corp of Engineers.

Powertech (USA) plans to construct several well fields and a CPP for the project. Where wetlands intersect the orebody, it has been assumed that impacts could occur from the presence of well fields. No wetland will be impacted due to the construction of the CPP. In the northwest section of the PAA, the ore bodies lie to the northeast of Beaver Creek; therefore, the wetlands along Beaver Creek will not be directly impacted by the well fields. The remaining disturbance areas in the PAA are located near a few small wetlands. These wetlands are not likely to have direct impacts from the presence of the well fields, but there may be indirect impacts due to the construction of the well fields. As noted in Section 2.8, the wetlands located within the PAA are recommended as non-jurisdictional except for the wetlands located along Beaver Creek that are recommended to be jurisdictional. In the event that construction, operation, or reclamation activities cause disturbance or potential impacts to jurisdictional wetlands on the proposed project, appropriate Nationwide Permits will be followed, if applicable.

Drainages or surface waters within the PAA will not be significantly impacted during construction or operations. In the northwest section of the of the PAA near Beaver Creek, erosion potential is present due to the construction of the wells near the drainage; however, this disturbance will be short-term and disturbed areas will be reclaimed concurrently as the well field progresses.

7.2.6.2 Potential Surface Water Effects from Sedimentation

The disturbance associated with normal construction activities, and heavy use of roads and activities associated with the wellfields, pipeline and CPP, have the potential to increase sediment yields. The potential impacts from increased sedimentation will be minimal because of the short-term nature of the disturbance (areas will be concurrently reclaimed) and the area of disturbance is small compared to the total drainage basin of Angostura Reservoir (total area 7143 square miles). Beaver Creek is the only perennial stream within the PAA and the rest of the natural water flow is ephemeral. Preventative sedimentation measures will be taken for disturbances that have the potential to increase sediment yields; therefore, potential impacts to surface water will be limited to uncommon precipitation or runoff events.

The modification of the land surface that is associated with ISL operations including well fields, a CPP, offices, roads and other structures should have a negligible impact on the peak surface water flow because the relatively planar topography of the PAA, low annual precipitation, and the comparatively small area of disturbance within the much larger Angostura Reservoir Basin.

7.2.6.3 Potential Surface Water Effects from Accidents

Potential impacts from accidents to surface water include the uncontrolled release of process materials into the environment or a release or spill from the operation or well field (e.g., handling of fuels, lubricant, oily wastes, chemical wastes, sanitary wastes, herbicides, and pesticides).

7.2.7 Potential Ecological Effects of Operations

The following section discusses the ecological potential impacts of operations at the project site.

7.2.7.1 Vegetation

Well field and production facilities will be constructed within Big Sagebrush Shrubland, Greasewood Shrubland, Ponderosa Pine Woodland, and Upland Grassland vegetation communities. Direct impacts include the short-term loss of vegetation (modification of structure, species composition, and aerial extent of cover types.) Indirect impacts may include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; reduction in livestock forage; and changes in visual aesthetics. An estimated 295.17 acres within the following four communities: Big Sagebrush Shrubland, Greasewood Shrubland, Ponderosa Pine Woodland, and Upland Grassland would be affected by the construction disturbance under current development plans.

Construction activities and increased soil disturbance could stimulate the introduction and spread of undesirable and invasive, non-native species within the PAA. Non-native species invasion and establishment has become and increasingly important result of previous and current disturbance in South Dakota. No threatened or endangered vegetation species were observed within the PAA; therefore, no impacts are anticipated.

7.2.7.2 Wildlife and Fisheries

ISL uranium production varies from typical open pit mining by using less intrusive extraction methods that are more efficient and, thus, have less impact on the surrounding area. In situ operations use a series of injection and production wells that extract the uranium from the orebody without physically removing the ore or overburden from the ground.

Despite the relatively limited surface disturbance associated with ISL uranium production, operations can have direct and indirect impacts on local wildlife populations. These impacts are both short-term (until successful reclamation is achieved) and long-term (persisting beyond successful completion of reclamation). However, the latter category is not expected to be substantial due to the relatively limited habitat disturbance associated with this industry. The direct impacts of ISL production on wildlife include: injuries and mortalities caused by collisions with project-related traffic or habitat removal actions such as topsoil stripping, particularly for smaller species with limited mobility such as some rodents and herptiles; and restrictions on wildlife movement due to construction of fences. The likelihood for the impacts resulting in injury or mortality is greatest during the construction phase due to increased levels of traffic and physical disturbance during that period. Overall traffic will increase from current levels and will persist during production, but should occur at a reduced, and possibly more predictable level than during the construction phase. Speed limits would be enforced during all construction and maintenance operations to reduce impacts to wildlife throughout the year, but particularly during the breeding season.

As indicated, most of the habitat disturbance associated with the ISL process itself will consist of scattered, confined drill sites for well heads that will not result in large expanses of habitat being dramatically transformed from its original character, as is the case with other surface mining operations. Therefore, most indirect impacts would relate to the displacement of wildlife due to increased noise, traffic, or other disturbances associated with the development and operation of the project, as well as from small reductions in existing or potential cover and forage due to habitat alteration, fragmentation, or loss. Indirect impacts typically persist longer than direct impacts. However, because ISL production results in fewer large-scale habitat alterations, the need for reclamation actions that can also result in dramatic differences between pre-construction and post-construction vegetative communities is also reduced.

Multiple site visits and targeted surveys conducted over the last year, combined with existing agency databases that encompass the PAA and input from local residents, indicate that the PAA and surrounding vicinity is occupied by a wide variety of common wildlife and fish species, with only a few species of particular concern occurring in the area. The most notable species of interest is the bald eagle, which is still considered threatened at the state level. Bald eagle winter roost sites and a successful nest site were documented within the PAA during surveys conducted in 2007 and 2008. Two other species tracked by the SDNHP were confirmed or suspected to have nested in the PAA in 2008, the long-eared owl and long-billed curlew, respectively. Eight additional SDNHP species were documented in or near the PAA during baseline surveys. However, those observations consisted of birds flying over the area, or sightings made in the surrounding perimeter. No grouse leks have been recorded within 6 miles of the PAA during agency or project-specific surveys completed in recent years.

Suitable habitat (trees and native uplands) for all three nesting SDNHP species occurs in the PAA. However, the nature of ISL production and the presence of apparently suitable (due to low density of other nesting individuals) alternate nesting habitat throughout the PAA and perimeter combine to minimizing the potential for both direct and indirect impacts for those species, and others that require similar habitats. One of those species, the long-eared owl, nested within 75 meters, but largely beyond view of, an existing gravel county road, suggesting the pair has at least some level of tolerance for vehicular traffic near active nest sites. Other wildlife species of concern, such as other nesting raptors, that occur in the area may also experience direct and/or indirect impacts from increased travel and noise in the area during project construction and operation. However, the presence of potential alternate nesting and foraging habitat in the immediate vicinity, the mobility of those species, and the location of most nest sites relative to planned disturbance combine to reduce impacts to most nesting SDNHP birds as well as other species of interest.

Some vegetative communities currently present in the PAA can be difficult to reestablish through artificial plantings, and natural seeding of those species would likely take many years. However, the current habitat of greatest concern (Big Sagebrush Shrublands) occurs only in scattered stands that are relatively small and widely-spread across the License area. Results from lek searches, breeding bird surveys, and small mammal trapping, as well as regular site visits in all seasons over the last year, strongly suggest that sage obligates other than pronghorn occur in limited numbers in the PAA, if at all. The vegetative communities (Cottonwood Gallery and Ponderosa Pine) that indicated the strongest associations between terrestrial species and habitats during baseline surveys will not be physically impacted by construction or operation of the proposed project. It is possible that the potential implementation of center-pivot irrigation using excess processing water may enhance nesting, brood-rearing, and/or foraging habitat for some species. Consequently, although individual animals associated with some specific habitats could be impacted by the proposed ISL operations, the small percentage of projected surface disturbance within the PAA relative to its overall size, and the low density of nesting efforts relative to habitat presence in that area, suggest that their populations as a whole will experience minimal insignificant impacts from the project. Advanced planning of construction siting and activities in concert with continued monitoring can further reduce impacts and assist with the development of mitigation options, if necessary. Potential impacts to these species and others are discussed in greater detail in the following sections.

7.2.7.3 Big Game

Big game could be displaced from portions of the PAA to adjacent areas, particularly during construction of the well field and facilities, when disturbance activities would be greatest. Disturbance levels would decrease during actual extraction operations, and would consist primarily of vehicular traffic on new and existing improved and unimproved (two-track) roads throughout the PAA. Similar disturbance is already present in the area due to existing ISL exploration, ranching, and railroad operations. Pronghorn antelope would be most affected, as they are more prevalent in the area. However, no areas classified as crucial pronghorn habitat occur on or within several miles of the PAA, and this species is not as common in the general area as elsewhere within the region due to the limited presence of sagebrush in the area. Mule deer would not be substantially impacted given their somewhat limited use of these lands, the paucity of winter forage and security cover, and the availability of suitable habitat in adjacent areas. SDGFP does not consider the PAA to be within the crucial habitat range of any other big game species. Sightings of those species in that vicinity are often seasonal and less common.

7.2.7.4 Other Mammals

Medium-sized mammals (such as lagomorphs, canids, and badgers) may be temporarily displaced to other habitats during the initial ISL production activities. Direct losses of some small mammal species (e.g., voles, ground squirrels, mice) may be higher than for other wildlife due to their more limited mobility and likelihood that they would retreat into burrows when disturbed, and thus be potentially impacted by topsoil scraping or staging activities. However, given the limited area expected to be disturbed by the project, such impacts would not be expected to result in major changes or reductions in mammalian populations for small or medium-sized animals. "Displaced species may re-colonize in adjacent, undisturbed areas or return to their previously occupied habitats after construction ends and suitable habitats are reestablished" (NUREG-1910, 2000). Few bats were recorded in the area despite extra efforts to observe them during the baseline surveys. Those that were seen were near water bodies near treed habitats which are not currently scheduled for disturbance. The mammalian species known to be, or potentially, present in the PAA have shown an ability to adapt to human disturbance in varying degrees, as evidenced by their continued presence in other mining and residential areas of similar, or greater, disturbance levels elsewhere in the region. Additionally, small mammal species in the area have a high reproductive potential and tend to re-occupy and adapt to altered and/or reclaimed areas quickly.

7.2.7.5 Raptors

ISL production in the PAA would not impact regional raptor populations, though individual birds or pairs may be affected. Production activity could cause raptors to abandon nest sites proximate to disturbance, particularly if activities encroach on active nests during a given breeding season. Within the current project plan there are no planned activities that would encroach on identified raptor nests. Other potential direct impacts would be injury or mortality due to collisions with project-related vehicular traffic. Construction activities that occur within or near active raptor territories could also cause indirect impacts such as reduction or avoidance of foraging habitats for nesting birds. However, surface disturbance will only occur in a small percentage of the overall PAA, and the low density of nesting raptors relative to the apparent availability of suitable habitat suggests that alternate nesting habitat is available for all known nesting raptor species in the PAA.

Eight intact raptor nests were documented within the project survey area (PAA and 2.0 km perimeter) during 2008; the mid-July 2007 start date for this project precluded nesting data from being collected last year. Six of the eight nest sites are within the PAA, with the remaining two located in the one-mile perimeter. USFWS guidelines recommend a non-disturbance buffer of 0.25 to 1.0 mile around active raptor nests for species known to nest, or suspected of nesting, in the PAA (USFWS, 1998). Buffer recommendations are lowest for the two owl species in the area, as they are typically more tolerant of human activities near active nest sites. The bald eagle has the greatest buffer distance around active nests, while a 0.5-mile buffer is recommended for red-tailed hawks and merlins. Nests of most other raptor species, including all others observed, but not documented nesting, in the proposed action area are typically buffered by a radius of 0.25 to 0.50 mile.

Except for the bald eagle, the same species that nest in the PAA are known to regularly nest and fledge young at or near other surface mines throughout the region, including ISL projects. Those efforts have succeeded due to a combination of raptors becoming acclimated to the relatively consistent levels of disturbance and gradual encroachment of production operations, and successfully executed state-of-the-art mitigation techniques to maintain viable raptor territories and protect nest productivity. Some individuals nest on active production facilities themselves, including both great horned owls and red-tailed hawks. The lack of bald eagle examples is more likely related to the general absence of nesting bald eagles in the vicinity, rather than an increased sensitivity to production activities. Bald eagles will be discussed further in the T&E section later in this document. Due to the paucity of river cliffs in the PAA, falcons and other raptors known to nest in that habitat are not as abundant as those that nest in trees or even on the ground.

Based on the location of known nest sites relative to future construction sites, no raptor nests will be physically disturbed by the project during either construction or operations. Additionally, Powertech (USA) has incorporated the baseline wildlife information into their planning process and sited all plant facilities (areas of greatest sustained future disturbance) outside the recommended buffer zone for all raptor nests in the PAA, including the bald eagle nest site. Some new infrastructure will be located within the suggested buffer areas. However, pipelines will be buried, and new overhead power lines will be constructed using designs and specifications to reduce injuries and mortalities on overhead power lines. Center-pivot structures can be put into place prior to the nesting season, and run automatically with little human contact once they are turned on. Additionally, new roads, power lines, and pipelines will be constructed in the same corridors to the extent possible to reduce overall disturbance, and in existing corridors when available to minimize new surface disturbance.

7.2.7.6 Upland Game Birds

ISL production in the PAA would potentially impact the foraging and nesting habitat of mourning doves, though such disturbance is not expected to have any marked impacts on this species. No woody corridors will be disturbed by the proposed activities, and additional trees are present in the cottonwood gallery along the Cheyenne River, located approximately 2 miles south of the PAA, where production is not projected to occur in the near future. Additionally, doves are not restricted to treed habitats, nor are they subject to any special mitigation measures for habitat loss.

Annual monitoring surveys conducted by SDGFP biologists and a year-round baseline study for the project have demonstrated that sage-grouse do not currently inhabit that area, and have not for many years. As described previously, those surveys encompassed the entire PAA (including the September 2008 configuration) and the vast majority of its 2.0 km (1.2 mi) perimeter, particularly as part of this baseline project. The nearest known sage-grouse lek is approximately 6.0 miles north of the PAA (SDGFP records). Given the lack of sage-grouse observations in the area, and the scattered stands of marginal quality sage-grouse habitat, the proposed project will not result in negative impacts to existing or potential sage-grouse leks, or important sagebrush habitats.

7.2.7.7 Other Birds

The project could potentially impact nine avian species tracked by SDNHP that are known to, or could potentially occur as seasonal or year-round residents. Direct impacts could include injury or mortality due to encounters with vehicles or heavy equipment during construction or maintenance operations. Indirect impacts could include habitat loss or fragmentation, and increased noise and activity that may temporarily deter use of the area by some species. Surface disturbance would be relatively minimal and would be greatest during construction. Enforced speed limits and use of common right-of-way corridors will reduce impacts to wildlife throughout the year, particularly during the breeding season.

7.2.7.8 Waterfowl and Shorebirds

Construction and operation of the uranium project would have a negligible effect on migrating and breeding waterfowl and shorebirds. Existing habitat is limited and seasonally available in the PAA, so it does not currently support large groups or populations of these species. Multiple approaches are being considered to minimize impacts to wildlife that may be associated with the operation of the ponds. Any new treated water sources could enhance current habitat conditions for these species, though such effects may be temporary in nature.

7.2.7.9 Reptiles and Amphibians

As with waterfowl, potential habitat for aquatic and semi-aquatic amphibians and reptiles, is limited within the PAA and occurs primarily along Beaver Creek in the western portion of the area. Other water bodies are ephemeral, and thus offer only short-term habitat. Activities associated with the project are not expected to disturb existing surface water or alter the topography in the area. Those species residing in rocky outcrops located in potential disturbance areas could be impacted by construction and maintenance operations. However, few non-aquatic herptile species were observed in the PAA and surrounding perimeter. Any impacts that would occur would affect individuals, but would not likely impact the population as a whole.

7.2.7.10 Fish and Macro-Invertebrates

The planned locations for new facilities and infrastructure do not overlap any perennial aquatic features, no loss of aquatic habitat would occur as the result of their construction. The risk of impaired water quality will be reduced or avoided through project siting, and implementation of standard construction erosion and sediment control measures. The location of project facilities (CPP, SF, pipelines, new roads and power lines), as well as the proposed land application sites (center pivot irrigation sites), will avoid direct impacts to perennial streams.

Due to the arid climate and proposed location of new project facilities, operation of the well fields is not expected to alter aquatic habitat or water quality in perennial streams. No surface water will be diverted for use in the operation, and no process water will be discharged into aquatic habitat.

Pass creek provides only seasonal drainage and does not support fish or significant amphibian habitat. Some of the proposed land application sites west of the SF would be located in close proximity to Beaver Creek, the primary aquatic habitat in the project vicinity. Beaver Creek would not be directly affected by the well field operations or land application sites.

7.2.7.11 Threatened, Endangered, or Candidate Species and Species Tracked by SDNHP

7.2.7.11.1 Federally Listed Species

As described in the preceding sections of this document, no federally listed vertebrate species were documented in the project survey area (current PAA and 2 km perimeter) during the year-long survey period, or during previous targeted surveys conducted for the original claims (TVA 1979). Additionally, the USFWS has issued a block clearance for black-footed ferrets in all black-tailed prairie dog colonies in South Dakota except northern Custer County, and in the entire neighboring state of Wyoming. That clearance indicates that ferrets do not currently, and are not expected to, occupy the PAA. Only one small black-tailed prairie dog colony was present in the PAA itself during the 2007-2008 baseline surveys, and local landowners are actively working to remove the animals from their lands. Consequently, the proposed project will have no direct, indirect, or cumulative effects on black-footed ferrets.

7.2.7.11.2 State Listed Species

ISL production within the project may affect, but is not likely to adversely affect bald eagles, the only state listed species known to inhabit the PAA. Bald eagles were documented at winter roosts and an active nest within the PAA for this project. However, most roost sites and the lone nest site are at least 1.0 mile from the nearest planned facility associated with this project. Additionally, no more than 2 or 3 bald eagles were observed during any given winter survey despite the numerous available (and unoccupied) mature trees along Beaver Creek, Pass Creek, and the pine breaks located in and near the PAA. Three proposed land application sites (center pivot irrigation systems) would currently fall within the one-mile buffer of the bald eagle nest. However, those systems are typically automated, and the minimal disturbance associated with potential maintenance of those systems should not be significant enough to impact nesting or roosting bald eagles along Beaver Creek.

Direct impacts to bald eagles would include the potential for injury or mortality to individual birds foraging in the PAA due to electrocutions on new overhead power lines. Although not expected, disturbance activities near an active nest could result in abandonment and, thus, the loss of eggs or young. The increased human presence and noise associated with construction activities, if conducted while eagles are wintering within the area, could displace individual eagles from using the area during that period.

Given the low number of wintering and nesting bald eagles in the PAA, potential impacts of the proposed project would be limited to individuals rather than a large segment of the population. The use of existing or overlapping right-of-way corridors, along with best management practices will minimize potential direct impacts associated with overhead power lines. If necessary, the majority of other potential impacts could be mitigated if construction activities were conducted outside the breeding season and/or winter roosting months, or outside the daily roosting period, should eagles be present within one mile of construction. Any bald eagles that might roost or nest in the area once the project is operational would be doing so in spite of continuous and on-going human disturbance, indicating a tolerance for such activities.

Indirect impacts as a result of noise and human presence associated from project related operations could include area avoidance by avian species. Potential winter foraging habitat could be further fragmented by linear disturbances such as overhead power lines and new roads associated with the project. Given the size of the proposed project, those disturbances would occur within narrow corridors over relatively short distances. Nevertheless, the use of common right-of-way corridors to consolidate new infrastructure will reduce these potential indirect impacts.

The only other state-listed species recorded in the general area was the river otter. An otter carcass was discovered lodged in debris in the stream channel at fisheries sampling station BVC04 in mid-April 2008. That site is approximately 12 river miles upstream from the PAA boundary in eastern Wyoming. The carcass had washed away by the July 2008 fisheries sampling session. The monthly sampling at BVC04 during the monitoring period, confirmed no additional observations of otters. Likewise, no evidence of otters was report by biologists along any drainage elsewhere in the PAA (proposed permit area and 2.0 km perimeter) during the year-long baseline survey period (mid-July 2007 through early August 2008). Given the fact that no stream channels will be physically impacted in the PAA, the lack of otter sightings or sign in the PAA itself, and the stringent water processing and water quality monitoring that will occur, this project is not likely to directly or indirectly impact river otters.

7.2.7.11.3 Species Tracked by SDNHP

Ten terrestrial species tracked by the SDNHP were recorded during baseline surveys for the uranium project, including the bald eagle. Seven of the ten were observed within the PAA, and three were seen in the 2.0 km perimeter. One additional species, the plains topminnow, was observed in Beaver Creek and the Cheyenne River, at least 1.0 mile outside the PAA. Three SDNHP species are known or suspected to have nested in the PAA in 2008. However, two of the three nest sites are at least 1.0 mile from the nearest planned new facility, and all three were closer to existing disturbances in 2008 than they would be to new activities outside those existing areas.

The seven SDNHP species recorded in or flying over the PAA could potentially experience the same type of direct and/or indirect impacts from construction and operation of the proposed operation as those described previously for other species: e.g., injury, mortality, avoidance, displacement and increased competition for resources. Those potential impacts will be minimized by the timing, extent, and duration of the proposed activities. Enforced speed limits during all phases of the project will further reduce potential impacts to wildlife throughout the year, particularly during the breeding season. Once facilities and infrastructure are in place, animals remaining in the PAA would demonstrate an acclimation to those disturbances.

7.2.8 Potential Noise Effects of Operations

Because of the remote location and lack sensitive receptors noise impacts are not expected to increase beyond ambient levels due to plant operations. Likewise, no detrimental off-site noise impacts are anticipated due to the increase in commuter and truck traffic volumes or from construction. Noise levels generated during operation of the project are not expected to result in any significant impacts to violate any noise standards. Exposure limits during operations will meet OSHA current permissible exposure limit for workplace noise (29 CFR 1910.95).

Outdoor noise levels at the nearest off-site receptors will be well within the 55-dBA daytime guideline, to protect against activity interference and annoyance (EPA, 1978). Noise levels during project operation and reclamation should cause no off-site impacts, since the PAA is not in close proximity to off-site receptors and will occur only during daylight hours.

7.2.9 Potential Cumulative Effects of Other Uranium Development Projects

The National Environmental Policy Act (NEPA) defines cumulative effects as "...impacts [that] can result from individually minor but collectively significant actions taking place over a period of time." The PAA is within the Nebraska – South Dakota – Wyoming Uranium Milling Region, which has a history of conventional uranium surface mining. According to the NRC GEIS there were no identified coal mines within this uranium milling region that might affect the cumulative impacts of the project or other uranium developments.

Within the Edgemont Uranium District, uranium was first discovered in 1951 and subsequently mined for a number of years using conventional surface mining methods. There are no Source Material Licenses for in situ uranium projects within fifty miles of the PAA. The nearest operational in situ facility is the Crow Butte ISL facility, SUA-1534, in Darrow County, near Crawford, Nebraska (U.S. NRC, 2008). Considering the distance between the existing projects and the proposed project and the almost half a century since the previous uranium development in the area, cumulative environmental impacts are considered to be small to negligible.

Powertech (USA) is currently investigating several prospective uranium ISL projects along with other companies within the Nebraska – South Dakota – Wyoming Uranium Milling Region. These projects are in various stages of development. At the time of this application Powertech (USA) is not aware of other licensing or permitting applications that have been submitted for any of these projects, therefore; Powertech (USA) can not accurately predict the cumulative impacts that potential projects that might have, should they be developed.

7.3 Potential Radiological Effects

This section includes an assessment of the radiological effects of the site, types of emissions the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The site will consist of two facilities. One facility will be the CPP, located near Burdock. The other facility will be the SF, located near Dewey.

Since the site will dispose of treated process water via land application, emission of natural uranium, lead-210 (Pb-210), radium-226 (Ra-226), and thorium-230 (Th-230) is expected. The release estimates for natural uranium, Pb-210, Ra-226, and Th-230 are calculated using methods found in "MILDOS-AREA: An Update with Incorporation of In Situ Leach Uranium Recovery Technology" by Faillace et al. and DOE Handbook "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities" by the US Department of Energy.

Due to the presence of Ra-226 in the soil from land application of wastewater, the land application areas will emit radon-222 (Rn-222), a decay product of Ra-226. The estimated release of Rn-222 is calculated using the previously mentioned methods as well as the methods found in Regulatory Guide 3.64, "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers" (RG 3.64) by the US Nuclear Regulatory Commission. The details of and assumptions used in these calculations are found in Section 7.3.3.2.1.

Since the drying and packaging operation, to be conducted at the CPP, will be under vacuum, the only expected routine emission at the facilities and well fields will be Rn-222 gas. Radon-222 is dissolved in the lixiviant as it travels through the ore to a production well where it is brought to the surface. The concentration of Rn-222 in the production solution and estimated releases are calculated using the methods found in Regulatory Guide 3.59, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (RG 3.59) by the Nuclear Regulatory Commission. The details of and assumptions used in these calculations are found in Sections 7.3.3.2.2 through 7.3.3.2.5.

MILDOS-AREA is used to model potential radiological impacts on human and environmental receptors (e.g. air and soil) using site-specific radionuclide release estimates, meteorological and population data, and other parameters. The estimated radiological impacts resulting from routine site activities will be compared to applicable public dose limits as well as naturally occurring background levels.

7.3.1 Potential Exposure Pathways

Figure 7.3-1 presents potential exposure pathways from all potential sources in the site. The predominant pathways for planned and unplanned releases are identified. As mentioned earlier, atmospheric Rn-222 is expected to be the predominant pathway for impacts on human and environmental media. Impacts of Rn-222 releases can be expected in all quadrants surrounding the site, the magnitude of which is driven predominantly by wind direction and atmospheric stability. As a noble gas, Rn-222 itself has very little radiological impact on human health or the environment. Radon-222 has a relatively short half-life (3.2 days) and its decay products are short lived, alpha emitting, nongaseous radionuclides. These decay products have the potential for radiological impacts to human health and the environment. As Figure 7.3-1 shows, all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radionuclides are evaluated by MILDOS-AREA.

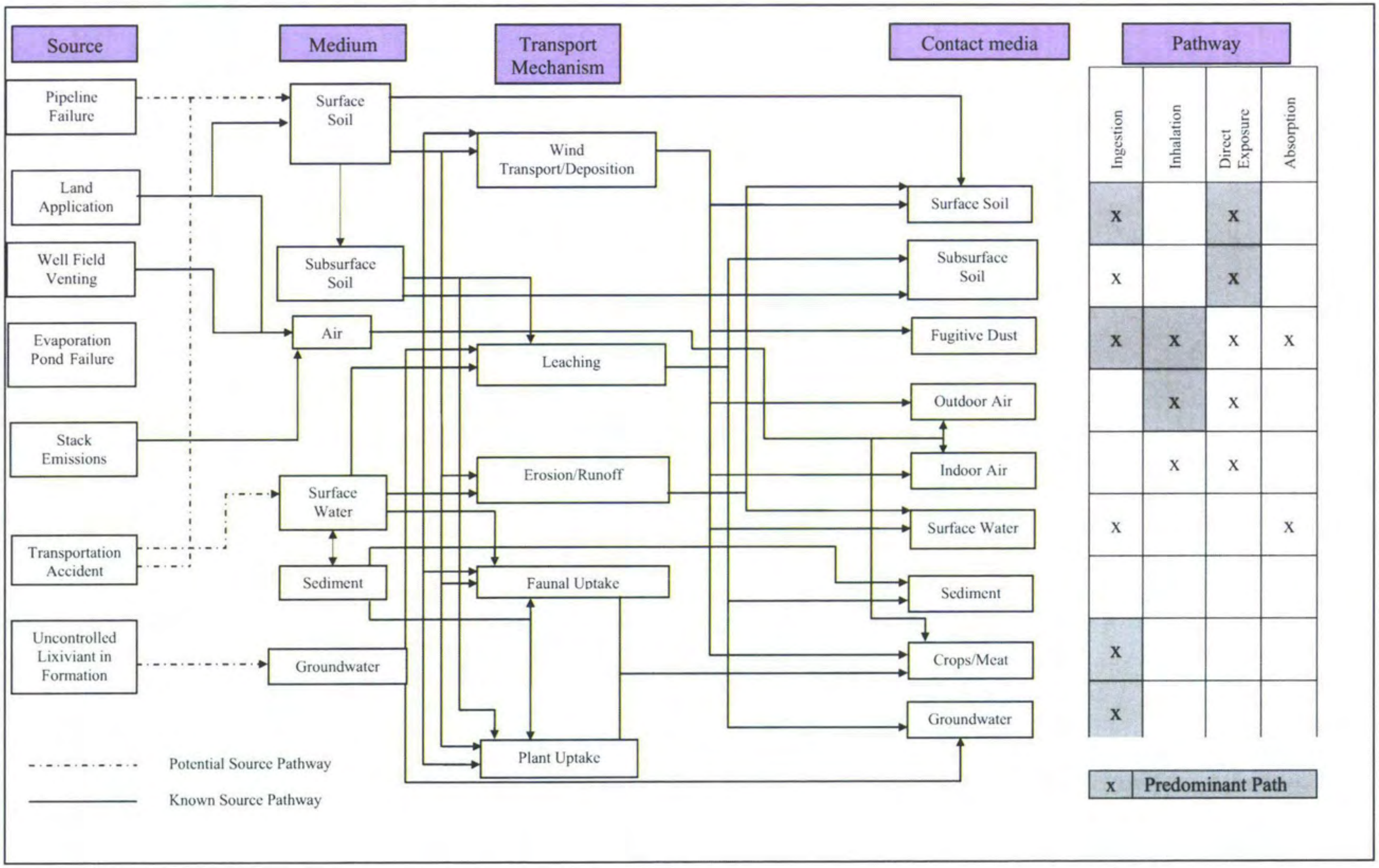

Figure 7.3-1: Human Exposure Pathways

7.3.2 Exposures from Water Pathways

The leach fluids in the ore zone will be controlled and monitored to ensure that migration does not occur. The overlying aquifers will also be monitored.

Two methods of waste disposal at the facility are being considered: Either treatment to remove radium and subsequent injection in a Class I or V disposal well, or by treatment followed by land application to irrigate an agricultural crop. Emission estimates from the land application processes are described in Sections 7.3.3.1 and 7.3.3.2.

The uranium IX, precipitation, drying and packaging facilities will be located on curbed concrete pads to prevent any liquids from entering the environment. Solutions used to wash down equipment drain to a sump and are either pumped back into the processing circuit or to wastewater treatment and disposal. The pads will be of sufficient size to contain the contents of the largest tank in the event of a rupture.

7.3.3 Exposures from Air Pathways

Sources of radionuclide emissions are Pb-210, natural uranium, Ra-226, and Th-230 released into the atmosphere from the land application areas. The land application areas are also a source of Rn-222, as are the well fields and the resin transfers at the SF. The total effective dose equivalent (TEDE) to nearby residents in the region and at the facility boundaries was estimated using MILDOS-AREA. The parameters used to estimate releases are provided in Table 7.3-1.

Table 7.3-1: Parameters Used to Estimate Radionuclide Releases from the Project Site

Parameter	Value	Unit	Variable Name	Source
Rate of land application - Dewey	3.05E-03	$m\ d^{-1}$	AR_{Dewey}	Application
Rate of land application - Burdock	2.29E-03	$m\ d^{-1}$	$AR_{Burdock}$	Application
Area of land application - Dewey	1.82E+06	m^2	LA_{Dewey}	Application
Area of land application - Burdock-1	1.01E+05	m^2	$LA_{Burdock-1}$	Application
Area of land application - Burdock-2	1.82E+06	m^2	$LA_{Burdock-2}$	Application
Area of land application - Burdock-3	5.06E+05	m^2	$LA_{Burdock-3}$	Application
Time of land application in a year	136	d	t_d	Application
Years of land application	15	y	t_y	Application
Concentration of natural uranium in water	300	$pCi\ L^{-1}$	$[U\text{-}nat]_{water}$	Application (NRC effluent values)
Concentration of thorium-230 in water	100	$pCi\ L^{-1}$	$[Th\text{-}230]_{water}$	Application (NRC effluent values)
Concentration of radium-226 in water	60	$pCi\ L^{-1}$	$[Ra\text{-}226]_{water}$	Application (NRC effluent values)
Concentration of lead-210 in water	10	$pCi\ L^{-1}$	$[Pb\text{-}210]_{water}$	Application (NRC effluent values)
Density of soil - Dewey	1.28	$g\ cm^{-3}$	ρ_{Dewey}	Application
Density of soil - Burdock	1.24	$g\ cm^{-3}$	$\rho_{Burdock}$	Application
Depth of contamination	0.15	m	x	Assumption
Distribution coefficient of natural uranium in loam soil	15	$cm^3\ g^{-1}$	$K_{d,U\text{-}nat}$	"Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil" by Yu et al.
Distribution coefficient of thorium-230 in loam soil	3300	$cm^3\ g^{-1}$	$K_{d,Th\text{-}230}$	"Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil" by Yu et al.
Distribution coefficient of radium-226 in loam soil	36000	$cm^3\ g^{-1}$	$K_{d,Ra\text{-}226}$	"Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil" by Yu et al.
Distribution coefficient of lead-210 in loam soil	16000	$cm^3\ g^{-1}$	$K_{d,Pb\text{-}210}$	"Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil" by Yu et al.
Soil volume water content - Dewey	0.91	unitless	w_{Dewey}	Application
Soil volume water content - Burdock	0.80	unitless	$w_{Burdock}$	Application
Rate of resuspension of radionuclides in surface soil	4E-06	h^{-1}	ARR	DOE Handbook "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities" by the US Department of Energy

7.3.3.1 Source Term Estimates – Natural Uranium, Pb-210, Ra-226, Th-230

The source terms used to estimate natural uranium, Pb-210, Ra-226, and Th-230 releases from the land application areas are calculated. The parameters used to estimate releases are provided in Table 7.3-1. In cases where site-specific information was not available, conservative values based on published information were used.

For purposes of modeling in MILDOS-AREA, the land application areas are consolidated into clusters. All the land application areas in Dewey are grouped into one cluster called "Dewey". The land application areas in Burdock are sorted into three clusters. One cluster, "Burdock-1", consists of one land application area northwest of the main plant. Another cluster, "Burdock-2", consists of twelve land applications areas between the main plant and the Burdock-1 cluster . The last cluster, "Burdock-3", consists of three land application areas southwest of the main plant. The locations of the sources representing the clusters are the centroids of the clusters.

The land application areas in Dewey have different soil properties than the land application areas in Burdock. As a result, the source terms for releases of the radionuclides are calculated separately for clusters in Dewey and Burdock. The radionuclide release rates are calculated using Equation 7.1 (from DOE Handbook "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities" by the US Department of Energy, modified by adding a factor converting h^{-1} to y^{-1}):

$$ST_{cluster,nu} = MAR_{cluster,nu} * DR * ARR * RF * LPF * 8760 \qquad \text{(Equation 7.1)}$$

Where:

ST	=	Radionuclide (nu) release rate (Ci y^{-1})
MAR	=	Amount of radionuclide in soil (Ci)
DR	=	Fraction of radionuclides available for resuspension
ARR	=	Rate of resuspension of radionuclides in surface soil (h^{-1})
RF	=	Respirable fraction of resuspended radionuclides in surface soil
LPF	=	Fraction of resuspended radionuclides passing through filtering, if any
cluster	=	Dewey, Burdock-1, Burdock-2, or Burdock-3
8760	=	Factor to convert h^{-1} to y^{-1}

In order to be conservative, all of the radionuclides in the soil of the land application clusters are assumed to be available for resuspension and there is no filtering. Therefore, both DR and LPF are assumed to be 1.

In the DOE Handbook "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities", the listed ARR for a homogenous bed of powder exposed to ambient conditions is 4E-05 hr^{-1}. However, that value is for "freshly deposited material" and "it would be inappropriate to use" this value for "releases for long-term contamination (i.e. months to years)." The experiment from which the ARR of 4E-05 hr^{-1} was found measured a range of ARRs of 4E-05 hr^{-1} to 4E-07 hr^{-1}. For calculations in this application, the mid-range value of 4E-06 hr^{-1} was used for the ARR.

Since land application is proposed to occur on several areas spread across the site, calculations of source terms are performed separately for Dewey and Burdock.

The radionuclide soil inventories resulting from land application are calculated using Equation 7.2:

$$MAR_{cluster, nu} = [nu]_{soil, cluster} * M_{cluster} * 10^{-12} \quad \text{(Equation 7.2)}$$

Where:

$[nu]_{soil}$	=	Concentration of radionuclide (nu) in soil (pCi g^{-1})
M	=	Mass of soil with radionuclide (g)
10^{-12}	=	Factor to convert pCi to Ci

The mass of soil contaminated in the land application at Dewey is different from the mass of soil contaminated in the land application at Burdock due to different soil densities.

The mass of soil contaminated in each land application cluster is calculated using Equation 7.3:

$$M_{cluster} = \rho_{area} * x * LA_{clsuter} * 10^6 \quad \text{(Equation 7.3)}$$

Where:

ρ	=	Density of soil (g cm^{-3})
area	=	Dewey or Burdock
x	=	Depth of contamination (m)
LA	=	Area used in land application (m^2)
10^6	=	Factor to convert cm^{-3} to m^{-3}

The concentrations of the various nuclides in the land application soils at Dewey and Burdock are calculated using Equation 7.4 (from "MILDOS-AREA: An Update with Incorporation of In Situ Leach Uranium Recovery Technology" by Faillace et al.):

$$[nu]_{soil, cluster} = \frac{[nu]_{water} * V_{cluster} * R_{s,area,nu} * 10^{-3}}{LA_{cluster} * x * \rho_{area}} \quad \text{(Equation 7.4)}$$

Where:

$[nu]_{water}$	=	Concentration of radionuclide in treated water (pCi L^{-1})
V	=	Volume of treated water used in land application (m^3)
R_s	=	Fraction of radionuclide in treated water retained in soil
10^{-3}	=	Factor to convert L^{-1} to cm^{-3}

The volume of treated water used in land application is calculated using Equation 7.5:

$$V_{cluster} = AR_{area} * t_d * t_y * LA_{cluster} \quad \text{(Equation 7.5)}$$

Where:

AR	=	Rate of land application (m d^{-1})
t_d	=	Time of land application in a year (d y^{-1})
t_y	=	Time of land application (y)

The area of land application is calculated in Equation 7.6:

The fraction of radionuclide in treated water retained in soil is calculated using Equation 7.6 (from "MILDOS-AREA: An Update with Incorporation of In situ Leach Uranium Recovery Technology" by Faillace et al.):

$$R_{s,area,nu} = 1 - \frac{1}{R_{d,area,nu}} \quad \text{(Equation 7.6)}$$

Where:
R_d = Retardation factor

The retardation factor is calculated using Equation 7.7 (from "MILDOS-AREA: An Update with Incorporation of In situ Leach Uranium Recovery Technology" by Faillace et al.):

$$R_{d,\,area,\,nu} = 1 + \frac{\rho_{area} * K_{d,\,nu}}{w_{area}} \qquad \text{(Equation 7.7)}$$

Where:
K_d = Distribution coefficient ($cm^3\ g^{-1}$)
w = Soil volume water content

Using the parameters in Table 7.3-1 and Equations 7.1-7, the release rates are calculated for natural uranium (U-Nat), thorium-230 (Th-230), radium-226 (Ra-226), and lead (Pb-210) and shown in Table 7.3-2.

Table 7.3-2: Estimated Soil Concentrations (pCi g^{-1}) and Release Rates (Ci y^{-1}) from the Project Site

Location	X (km)	Y (km)	U-Nat		Th-230		Ra-226		Pb-210	
			Soil Conc.	Rel. Rate	Soil Conc.	Rel. Rate	Soil Conc.	Rel. Rate	Soil Conc.	Rel. Rate
Land Application - Dewey	-5.67	4.09	9.28	0.114	3.24	0.0397	1.94	0.0238	0.324	0.00397
Land Application - Burdock-1	-1.48	2.31	7.22	0.00476	2.51	0.00165	1.51	0.000992	0.251	0.000165
Land Application - Burdock-2	-0.90	1.10	7.22	0.0857	2.51	0.0298	1.51	0.0179	0.251	0.00298
Land Application - Burdock-3	-1.57	-1.50	7.22	0.0238	2.51	0.00828	1.51	0.00497	0.251	0.000828

7.3.3.2 Source Term Estimates – Rn-222

Sources of radon emanation are the land application areas, the well fields, the CPP, and resin transfers in the SF. The well fields consist of production well fields, restoration well fields, and new well fields. In order to be conservative, the well field in Dewey closest upwind to a receptor (Mining Unit 5) was modeled in MILDOS-AREA. Likewise, the well field in Burdock closest upwind to a receptor (Mining Unit 2) was modeled in MILDOS-AREA.

7.3.3.2.1 Land Application Releases

In addition to natural uranium, Ra-226, Pb-210, and Th-230; the land application areas are also sources of Rn-222. The radon source term is calculated using Equation 7.8 and the parameters listed in Table 7.3-1:

$$ST_{cluster} = J_{cluster} * A_{cluster} * 3.15 * 10^{-5} \qquad \text{(Equation 7.8)}$$

Where:

J	=	Radon flux (pCi m^2 s^{-1})
$3.15 * 10^{-5}$	=	Factor to convert pCi s^{-1} to Ci y^{-1}

The radon flux is calculated using Equation 7.9 (from RG 3.64):

$$J_{cluster} = [Ra-226]_{soil,cluster} * \rho_{area} * E_{area} * \sqrt{\lambda * D_{area}} * 10^4 * \tanh\left(x * \sqrt{\frac{\lambda}{D_{area}}}\right) \qquad \text{(Equation 7.9)}$$

Where:

E	=	Radon emanation coefficient
λ	=	Radon-222 decay constant (2.1E-06 s^{-1})
D	=	Radon diffusion coefficient (cm^2 s^{-1})
10^4	=	Factor to convert cm^{-2} to m^{-2}

The radon diffusion coefficient is calculated using Equation 7.10 (from RG 3.64):

$$D_{area} = 0.07 * e^{\left[-4*\left(w_{area} - n_{area}^{2} * w_{area} + w_{area}^{5}\right)\right]} \qquad \text{(Equation 7.10)}$$

Where:

n	=	Porosity

Using the parameters listed in Table 7.3-1 and Equations 7.8-10, the release rates of Rn-222 from land application are calculated. The releases are 7.43 Ci y^{-1} for Dewey, 0.38 Ci y^{-1} for Burdock-1, 6.88 Ci y^{-1} for Burdock-2, and 1.91 Ci y^{-1} for Burdock-3.

7.3.3.2.2 Production Releases

Plans are to have up to two areas which potentially could be operated concurrently. The potential Rn-222 releases from the production well fields were estimated using methods described in RG 3.59 as follows:

The yearly radon released to the production fluid is calculated using Equation 7.11:

$$Y = 1.44 * G * M_{production} * D * (1 - e^{-\lambda * t}) \qquad \text{(Equation 7.11)}$$

Where:

Y	=	Yearly radon released to production fluid (Ci y^{-1})
G	=	Radon released at equilibrium (Ci m^{-3})
M	=	Lixiviant flow rate (L min^{-1})
D	=	Production days per year (d)
λ	=	Radon-222 decay constant (d^{-1})
t	=	Lixiviant residence time
1.44	=	Factor to convert L min^{-1} to m^3 y^{-1}

Radon released (equilibrium condition) to production fluid from leaching is calculated using Equation 7.12:

$$G = R * \rho_{form} * E * \frac{(1 - n_{form})}{n_{form}} * 10^{-6} \qquad \text{(Equation 7.12)}$$

Where:

G	=	Radon released (Ci m^{-3})
R	=	Radium content of ore (pCi g^{-1})
E	=	Radon emanation coefficient
ρ_{form}	=	Formation density (g cm^{-3})
n_{form}	=	Formation porosity

Using Equations 7.11-12 and the parameters listed in Table 7.3-1, the yearly radon released to production fluid is 2117 Ci y^{-1}. RG 3.59 assumes all the Rn-222 that is released to the production fluid is ultimately released to the atmosphere which in the case of IX columns operating at atmospheric pressure in an open system is an appropriate conservative assumption. In cases where pressurized downflow IX columns are used, and well fields are operated under pressure, the majority of radon released to the production fluid stays in solution and is not released. The radon which is released is from occasional well field venting for sampling events, small unavoidable leaks in well field and IX equipment, and maintenance of well field and ion change equipment. For this reason, estimated annual releases of 10 percent of the Rn-222 in the production fluid would occur in the well fields and an additional 10 percent in the IX circuit was assumed. Given these assumptions, the annual Rn-222 released from production in the well field and at the CPP is 212 and 191 Ci y^{-1}, respectively. Since the SF is planned to operate at the same parameters as the CPP, the annual Rn-222 released from production in the well field and at the SF is also 212 and 191 Ci y^{-1}, respectively. This 10 percent release rate also includes Rn-222 released from the 1-5 percent bleed from the production well field.

7.3.3.2.3 Restoration Releases

Radon-222 releases resulting from well field restoration activities were estimated in the same manner as the production activities above (i.e. using Equations 7.11-12) but modified for the lower restoration flow rate listed in Table 7.3-1. The assumption of a 10 percent release in the well field and the CPP results in releases of 26.5 and 23.8 Ci y^{-1}, respectively. Since the SF is planned to operate at the same parameters as the CPP, the annual Rn-222 released from production in the well field and at the SF is also 26.5 and 23.8 Ci y^{-1}, respectively.

7.3.3.2.4 New Well Field Releases

Radon-222 releases resulting from new well field development activities were estimated using methods described in NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* (NUREG-1569) by the US Nuclear Regulatory Commission as follows:

The yearly radon released new well field development is calculated using Equation 7.13:

$$Rn_{nw} = E * L * [Ra]_{ore} * T * m * N * 10^{-12} \qquad \text{(Equation 7.13)}$$

Where:

Rn_{nw}	=	Radon-222 release rate from new well field (Ci y^{-1})
$[Ra]_{ore}$	=	Concentration of radium-226 in ore (pCi g^{-1})
L	=	Decay constant of radon-222 (0.181 d^{-1})
T	=	Storage time in mud pit (d)
m	=	Average mass of ore material in the pit (g)
N	=	Number of mud pits generated per year (y^{-1})
10^{-12}	=	Factor to convert pCi to Ci

Using Equation 7.13 and the parameters listed in Table 7.3-1, the yearly radon released from new well field development is 3.6E-05 Ci yr^{-1}.

7.3.3.2.5 Resin Transfer Releases

Radon-222 releases resulting from resin transfers at the SF are estimated using methods described in NUREG-1569 as follows:

The yearly radon released new well field development is calculated using Equation 7.14:

$$Rn_x = 3.65 * 10^{-10} * F_i * C_{Rn} \qquad \text{(Equation 7.14)}$$

Where:

Rn_x	=	Radon release rate from resin transfers (Ci y^{-1})
F_i	=	Water discharge rate from resin unloading (L d^{-1})
C_{Rn}	=	Steady state radon-222 concentration in process water (pCi L^{-1})
$3.65 * 10^{-10}$	=	Factor to convert pCi d^{-1} to Ci yr^{-1}

The steady state radon-222 concentration in process water can be estimated using Equation 7.15:

$$C_{Rn} = \frac{Y * 1.9 * 10^6}{M} \qquad \text{(Equation 7.15)}$$

Where:

C_{Rn}	=	Steady state radon-222 concentration in process water (pCi L^{-1})
Y	=	Yearly radon released to production fluid (Ci y^{-1})
M	=	Lixiviant flow rate (L min^{-1})
$1.9 * 10^6$	=	Factor to convert Ci y^{-1} to pCi min^{-1}

The water discharge rate from resin unloading (F_i) can be estimated using Equation 7.16:

$$F_i = N_{resin} * V_i * P_i \qquad \text{(Equation 7.16)}$$

Where:

F_i	=	Water discharge rate from resin unloading (L d^{-1})
N_i	=	Number of resin transfers per day (d^{-1})
V_i	=	Volume of resin in transfer (L)
n_{resin}	=	Porosity of resin

Using Equations 7.13-16 and the parameters listed in Table 7.3-1, the yearly radon released from resin transfers at the SF is 0.523 Ci y^{-1}. This assumes the ore grade mined at the SF would yield the same radon concentration in production fluid as at the CPP.

7.3.3.2.6 Radon-222 Release Summary

A summary of estimated radon-222 releases from the site is presented in Table 7.3-3. The source coordinates in Table 7.3-3 are relative to the CPP.

Table 7.3-3: Estimated Releases (Ci y^{-1}) of Radon-222 from the Project Site

Location	X (km)	Y (km)	Production	Restoration	Drilling	Resin Transfer	Land Application	Total
Production Mine Unit (5)	-3.86	3.48	212	26.5	3.6E-05	0	0	238.5
Production Mine Unit (2)	1.83	-0.56	212	26.5	3.6E-05	0	0	238.5
SF	-5.00	3.54	191	23.8	0	0.523	0	215.3
CPP	0	0	191	23.8	0	0	0	214.8
Land Application - Dewey	-5.67	4.09	0	0	0	0	7.43	7.43
Land Application - Burdock-1	-1.48	2.31	0	0	0	0	0.38	0.38
Land Application - Burdock-2	-0.90	1.10	0	0	0	0	6.88	6.88
Land Application - Burdock-3	-1.57	-1.50	0	0	0	0	1.91	1.91
Total			806	100.6	3.6E-05	0.523	16.60	924

7.3.3.3 Receptors

The receptors used in the MILDOS-AREA simulations are presented in Table 7.3-4 and include the property boundary in 16 compass directions of the CPP and SF, 7 residences, and the town of Edgemont.

Table 7.3-4: Project Receptor Names and Locations

Location	X (km)	Y (km)	Distance (km)
Boundary - CPP - N	0.00	2.82	2.82
Boundary - CPP - NNE	1.07	2.78	2.96
Boundary - CPP - NE	1.16	1.17	1.65
Boundary - CPP - ENE	2.64	1.01	2.83
Boundary - CPP - E	2.60	0.00	2.60
Boundary - CPP - ESE	2.53	-0.97	2.71
Boundary - CPP - SE	2.13	-2.14	3.02
Boundary - CPP - SSE	0.85	-2.25	2.41
Boundary - CPP - S	0.00	-2.87	2.87
Boundary - CPP - SSW	-1.09	-2.84	3.04
Boundary - CPP - SW	-2.44	-2.43	3.44
Boundary - CPP - WSW	-2.37	-0.90	2.54
Boundary - CPP - W	-2.32	0.00	2.32
Boundary - CPP - WNW	-2.29	0.87	2.45
Boundary - CPP - NW	-2.55	2.52	2.45
Boundary - CPP - NNW	-1.42	3.70	3.96
Boundary - SF - N	-4.92	5.28	7.22
Boundary - SF - NNE	-4.23	5.25	6.74
Boundary - SF - NE	-2.70	5.64	6.25
Boundary - SF - ENE	-3.35	4.01	5.23
Boundary - SF - E	-2.97	3.43	4.54
Boundary - SF - ESE	-3.00	2.69	4.03
Boundary - SF - SE	-2.81	1.30	3.10
Boundary - SF - SSE	-3.55	-0.15	3.55
Boundary - SF - S	-4.91	-0.25	4.92
Boundary - SF - SSW	-5.70	1.38	5.86
Boundary - SF - SW	-6.28	2.06	6.61
Boundary - SF - WSW	-6.24	2.92	6.89
Boundary - SF - W	-7.02	3.43	7.81
Boundary - SF - WNW	-6.98	4.21	8.15
Boundary - SF - NW	-6.24	4.69	7.81
Boundary - SF - NNW	-5.40	4.67	7.14
Resident - Daniels Ranch	2.13	0.02	2.13
Resident - Spencer Ranch	-2.00	1.21	2.34
Resident - BC Ranch	-6.64	3.81	7.66
Resident - Puttman Ranch	-5.16	7.23	8.88
Resident - Burdock School	-2.25	-1.96	2.98
Resident - Heck Ranch	1.73	-6.38	6.61
Resident - Englebert Ranch	0.30	-4.83	4.84
Town - Edgemont	11.03	-18.59	21.62

7.3.3.4 Miscellaneous Parameters

The metrological data used in the MILDOS-AREA model is from the joint frequency distribution data presented in Section 2.5.2 of this application.

The population distribution used in the MILDOS-AREA model to estimate population doses is from the demographic information presented in Section 2.3 of this application.

7.3.3.5 Total Effective Dose Equivalent (TEDE) to Individual Receptors

In order to show compliance with the annual dose limit found in 10 CFR part 20.1301, Powertech (USA) has demonstrated by calculation that the total TEDE to the individual most likely to receive the highest dose from the project uranium in situ recovery operation is less than 100 mrem y^{-1}. Additionally, the annual effective dose equivalent (EDE) limit found in 40 CFR part 190 of 25 mrem y^{-1} was not exceeded at any receptors. The results of the MILDOS-AREA simulation for each receptor in Table 7.3-4 are presented in Table 7.3-5. The output from the MILDOS-AREA simulation for the land application option is in Appendix 7.3-A. The output for the MILDOS-AREA simulation for the waste disposal well option is in Appendix 7.3-B.

An evaluation of the TEDE calculations follows:

- The maximum 40 CFR part 190 EDE of 10.8 mrem y^{-1}, located at the property boundary north-northwest of the SF, is 43.2 percent of the public dose limit of 25 mrem y^{-1}. The 40 CFR 109 TEDE public dose limit is not exceeded at any boundary receptor. If the land application sources were excluded from the MILDOS-AREA model, no doses would exceed the 40 CFR part 190 dose limit since this limit specifically excludes sources of radon-222.

- The maximum total TEDE of 12.5 mrem per year, located at the property boundary north-northwest of the SF, is 12.5 percent of the 10 CFR 20 public dose limit of 100 mrem y^{-1}. The 10 CFR 20 public dose limit is not exceeded at any property boundary. If the land application sources were excluded form the MILDOS_AREA model, the TEDE at this location would be 2.5 mrem y^{-1}.

- The maximum 40 CFR part 190 EDE at a resident is 2.32 mrem y^{-1}, located at Spencer Ranch. This is 9.28 percent of the public dose limit of 25 mrem y^{-1}. None of the resident receptors have 40 CFR part 190 EDEs exceeding the 25 mrem y^{-1} public dose limit. None of these estimated EDEs exceed the 10 CFR 20 constraint rule for airborne effluents of 10 mrem y^{-1}. If the land application sources were excluded from the MILDOS-AREA model, no doses would exceed the 40 CFR part 190 dose limit for reasons discussed above.

- The maximum TEDE at a resident is 4.48 mrem y^{-1}; located at Spencer Ranch. It is 4.48 percent of the 10 CFR 20 public dose limit of 100 mrem y^{-1}. None of the residents have TEDEs exceeding the 100 mrem y^{-1} public dose limit. If the land application sources were excluded from the MILDOS-AREA model, the TEDE at this location would be 1.72 mrem y^{-1}.

Table 7.3-5: Estimated Total Effective Dose Equivalents (TEDE) to Receptors Near the Project Site

Receptor	Distance from Main Plant (km)	40 CFR part 190 TEDE (mrem y^{-1})	Total TEDE (mrem y^{-1})
Boundary - CPP - N	2.82	1.20	2.32
Boundary - CPP - NNE	2.96	0.864	1.79
Boundary - CPP - NE	1.65	1.89	3.43
Boundary - CPP - ENE	2.83	1.06	2.17
Boundary - CPP - E	2.60	1.42	3.23
Boundary - CPP - ESE	2.71	1.49	5.11
Boundary - CPP - SE	3.02	1.59	5.39
Boundary - CPP - SSE	2.41	2.09	5.36
Boundary - CPP - S	2.87	2.13	4.59
Boundary - CPP - SSW	3.04	2.33	4.17
Boundary - CPP - SW	3.44	1.29	2.86
Boundary - CPP - WSW	2.54	1.76	3.65
Boundary - CPP - W	2.32	1.98	4.16
Boundary - CPP - WNW	2.45	2.30	4.59
Boundary - CPP - NW	2.45	2.15	4.72
Boundary - CPP - NNW	3.96	1.21	2.31
Boundary - SF - N	7.22	1.37	2.62
Boundary - SF - NNE	6.74	1.06	2.24
Boundary - SF - NE	6.25	0.727	1.52
Boundary - SF - ENE	5.23	1.79	3.54
Boundary - SF - E	4.54	1.90	4.30
Boundary - SF - ESE	4.03	2.23	6.08
Boundary - SF - SE	3.10	2.25	5.22
Boundary - SF - SSE	3.55	1.51	3.96
Boundary - SF - S	4.92	1.01	2.82
Boundary - SF - SSW	5.86	1.52	3.16
Boundary - SF - SW	6.61	1.41	2.59
Boundary - SF - WSW	6.89	2.23	3.38
Boundary - SF - W	7.81	1.08	1.85
Boundary - SF - WNW	8.15	1.23	1.90
Boundary - SF - NW	7.81	3.63	4.55
Boundary - SF - NNW	7.14	10.8	12.5
Resident - Daniels Ranch	2.13	1.64	3.43
Resident - Spencer Ranch	2.34	2.32	4.48
Resident - BC Ranch	7.66	1.23	2.06
Resident - Puttman Ranch	8.88	0.596	1.25
Resident - Burdock School	2.98	1.86	3.56
Resident - Heck Ranch	6.61	0.771	2.27
Resident - Englebert Ranch	4.84	0.978	2.74
Town - Edgemont	21.61	0.200	0.572

7.3.3.6 Population Dose

The annual population dose commitment to the population in the region within 80 km of the project site is also predicted by the MILDOS-AREA code. The results are contained in Table 7.3-6 where TEDE is expressed in terms of person-rems. For comparison, the dose to the population within 80 km of the facility due to background radiation has been included in the table. Background radiation doses are based on a North American population of 346 million and an average TEDE of 360 mrem.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming, during the year 1978. The results of these calculations are included in Table 7.3-6. These calculations are also combined with the dose to the region within 80 km (50 mi) of the facility to arrive at the total radiological effects of one year of operation at the project site.

The maximum radiological effect of the project operation would be to increase the TEDE of continental population by 7.5E-6 percent.

Table 7.3-6: Total Effective Dose Equivalent to the Population from One Year's Operation at the Project Site

Criteria	TEDE (person rem/yr)
Dose received by population within 80 km of the facility	0.879
Dose received by population beyond 80 km of the facility	8.13
Total continental dose	9.01
Background North American dose	1.2E8
Fractional increase to background dose	7.5E-8

7.3.3.7 Exposure to Flora and Fauna

MILDOS-AREA estimates surface deposition rates of Ra-226 and its decay products as a function of distance from the source and calculates surface concentrations. Table 7.3-7 presents the highest surface concentrations of Ra-226 and its decay products predicted by MILDOS-AREA over a 100-year period. Soil concentrations were calculated based on a conservative assumption of 1.5 g cm^{-3} bulk soil density.

Table 7.3-7: Highest Surface Concentrations of Radium-226 and its Decay Products

Radionuclide	Distance from site (km)	Direction	Surface concentration ($pCi\ m^{-2}$)	Soil concentration in upper 15cm ($pCi\ g^{-1}$)
Radium-226	1.5	WNW	9.94E+03	0.0442
Polonium-218	1.5	WNW	9.94E+03	0.0442
Lead-214	1.5	WNW	9.94E+03	0.0442
Bismuth-214	1.5	WNW	9.94E+03	0.0442
Lead-210	15.0	S	254	1.13E-3

The largest increase in soil concentration is 0.0442 pCi g^{-1} of radium-226, polonium-218, lead-214, and bismuth-214. Recent site specific surface soil (0-15 cm) data show that the background concentration of radium-226 ranges from 0.76 (25 percentile) to 2.2 (75 percentile) pCi g^{-1} with a geometric mean of 1.3 pCi g^{-1} and geometric standard deviation of 1.3 pCi g^{-1}. The increase in soil radioactivity is less than the geometric mean soil radioactivity prior to uranium recovery operations and if added to the geometric mean (1.4 pCi g^{-1}) is still within normal background variability observed at the site. Assuming the most important pathways to flora and fauna exposure start with radionuclide concentrations in soil, the impacts from normal site operations would be minimal and probably not distinguishable from background.

7.3.3.8 Determination of Land Application Effects

7.3.3.8.1 Potential Radiological Effects

RESRAD Version 6.4 computer code (RESRAD) was used to model the site and calculate the maximum annual dose rate from the land application processes for a resident farmer scenario.

The soil concentration parameters used in the model were the soil concentrations calculated for the Dewey cluster in Section 7.3.3.1. The soil concentrations for Dewey were chosen because they are they are the most conservative (higher than) when compared to the Burdock cluster. The soil concentrations are 9.28 pCi g^{-1} for U-nat, 3.24 pCi g^{-1} for Th-230, 1.94 pCi g^{-1} for Ra-226, and 0.324 pCi g^{-1} for Pb-210. However, U-nat is composed of three isotopes of uranium: urainium-234 (U-234), uranium-235 (U-235), and uranium-238 (U-238).

The activity composition of U-nat is 49.2 percent U-234, 2.2 percent U-235, and 48.6 percent U-238. Therefore the 9.28 pCi g^{-1} of U-nat is composed of 4.57 pCi g^{-1} U-234, 0.204 pCi g^{-1} U-235, and 4.51 pCi g^{-1} U-238. These concentrations were used in the model.

The area of contamination used in the model was the area of the Dewey cluster, 450 acres. The distribution coefficients that were selected for each radionuclide were RESRAD default values. All other input parameters were the same as those used in the Ra-226 benchmark modeling described in Attachment 1 of Appendix 6.4-A and in Section 6.4.

The maximum annual dose rate from the land application areas, including radon, is 52.9 mrem y^{-1} at t = 0 years. Not including radon, the dose rate is 12.9 mrem y^{-1}. The major exposure pathways are radon, external, and plant (water independent). The dose figures generated with RESRAD are in Attachments 4.0 and 4.1 of Appendix 6.4-A and a full printout of the final RESRAD modeling results is in Attachments 3.0 and 3.1 of Appendix 6.4-A. This shows that the radiological impacts of the land application process are minimal and meet the license termination for unrestricted use criteria in 10CFR 20.1402 of 25 mrem per year to a critical group.

7.3.3.8.2 Potential Non-radiological Effects

Steady-state, non-radioactive metals concentrations in the land application area surface soils were determined using Equations 7.4 though 7.6. As it originally applied to radionuclides, the unit of concentration in Equation 7.4 was changed from pCi/L to mg/L. The mineral-water distribution (or fractionation) coefficient (K_d) for each metal was either adopted from default values in RESRAD v.6.4, Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil (Argonne 1993) or, if unavailable, the soil retention fraction (R_s in Equation 7.4) was conservatively assumed to be one. End of Production water quality estimates (Table 7.3-8) were used for the non-radiological parameter source term estimates.

The steady-state soil concentrations of metals are compared to EPA Region 9 generic Soil Screening Levels (SSLs) in Table 7.3-8. Each SSL represents a $1*10^{-6}$ excess cancer risk posed by non-additive ingestion of each of the metals or inhalation of chromium as chromium (VI).

The framework for EPA SSLs is presented in "Soil Screening Guidance: User's Guide," EPA/540/R-018, dated July 1996 (EPA 1996). The soil screening guidance states that the prevalent exposure pathway to metals in soil is direct ingestion. The guidance recommends that dermal contact need not be considered for metals and inhalation of fugitive dust need only be considered for chromium (VI).

The assumptions used to derive the generic SSLs appeared to be reasonable for the Dewey and Burdock land application areas. The equation used to determine the screening level for ingestion of non-carcinogenic contaminants in a residential use endpoint is:

$$ScreeningLevel(mg/kg) = \frac{THQ\,x\,BW\,x\,AT\,x\,RfD_o\,x\,365}{10^{-6}\,x\,EF\,x\,ED\,x\,IR}$$

Where:

THQ	=	Target hazard quotient, default value is 1
BW	=	Body weight, default value is 15 kilograms
AT	=	Averaging time, default value is 6 years
RfD_o	=	Oral reference dose, mg/kg-d, chemical specific
EF	=	Exposure frequency, default value is 350 d/yr
ED	=	Exposure duration, default value is 6 years
IR	=	Soil ingestion rate, default value is 200 mg/d

The equation used to determine the screening level for ingestion of carcinogenic contaminants in a residential use endpoint is:

$$ScreeningLevel(mg/kg) = \frac{TR\,x\,AT\,x\,365}{SF_o\,x\,10^{-6}\,kg/mg\,x\,EF\,x\,IF}$$

Where:

TR	=	Target cancer risk, default value is $1*10^{-6}$
AT	=	Averaging time, default value is 70 years
SF_o	=	Oral slope factor, $(mg/kg\text{-}d)^{-1}$, chemical specific
EF	=	Exposure frequency, default value is 350 d/yr
IF	=	Age-adjusted soil ingestion factor, default value is 114 mg-yr/kg-d

The equation to determine the screening level for inhalation of carcinogenic contaminants (chromium only) in a residential use endpoint is:

$$ScreeningLevel(mg/kg) = \frac{PEF\,x\,TR\,x\,AT\,x\,365}{URF\,x\,1000\,\mu g/mg\,x\,EF\,x\,ED}$$

Where:

PEF	=	Particulate Emission Factor, default value is $1.32*10^{9}$ m^3/kg
TR	=	Target cancer risk, default value is $1*10^{-6}$
AT	=	Averaging time, default value is 70 years
URF	=	Inhalation unit risk factor, $(\mu g/m^3)^{-1}$, 0.084 for chromium (VI) particulates

EF = Exposure frequency, default value is 350 d/yr
ED = Exposure duration, default value is 30 years

As shown in Table 7.3-8 no metals with steady state surface soil concentrations exceed their respective SSL at either location.

Table 7.3-8: Steady-State Metals Concentrations and Respective SSLs in Land Application Area Surface Soils

	Concentration in Applied Water (mg/L)		Concentration in Soil (mg/kg)		
Metal	**Dewey**	**Burdock**	**Dewey**	**Burdock**	**EPA Region 9 SSL (mg/kg)**
Arsenic	0.01	0.01	0.32	0.19	0.39 ca[a]
Barium	0.32	0.32	10.4	8.0	15,000
Cadmium	0.33	0.33	10.5	8.2	70[b]
Chromium	0.325	0.325	10.3	8.0	Chromium (III) insoluble salts: $1.2*10^5$ Chromium (VI) particulates: 39 ca[c] Chromium, Total (1:6 ratio Cr VI : Cr III): 280
Copper	0.272	0.272	8.8	6.8	3,100
Iron	1.1	0.2	35.6	27.6	55,000
Lead	10	10	324	251	400
Nickel	0.29	0.29	9. 4	7.2	1,600[d]
Selenium	0.2	0.2	6.5	5.0	390
Vanadium	10	6	324	151	390

Notes:
a. ca= cancer endpoint
b. dietary cadmium
c. exposure via inhalation
d. nickel as soluble salts

7.4 Potential Non-Radiological Effects

NUREG-1569 requires that estimates of concentrations of nonradioactive constituents in effluents at the points of discharge be compared to natural ambient concentrations with applicable discharge standards. There will be two effluents from the project; a gaseous airborne effluent and a liquid effluent.

The gaseous airborne effluent will consist of the ventilated air from the plant's ventilation system, originating from the process vessels and tanks. Radon gas will be present in this effluent as discussed in Section 7.2.1 above. No non-radiological effluents will be present in the gaseous airborne effluent. Non-radioactive airborne effluents from the project will be composed of fugitive dust from site roads and well field activities. Dust suppressants will be used to mitigate fugitive dust emissions if deemed necessary depending on-site conditions.

Powertech (USA) is currently considering two scenarios for liquid effluent disposal. The first involves management of well field "bleed" water and well field restoration water on-site using evaporation ponds and land application. Brines from the CPP will be disposed offsite in a waste disposal well located in Burns, Wyoming. The second scenario involves management of well field "bleed" water, well field restoration brine water, and CPP brine water offsite in waste disposal wells. Under this scenario, there will be no on-site ponds or land application facilities. As the project is moves forward, the feasibilities of either scenarios or some combination of two scenarios will be evaluated and a determination will be made based on effectiveness, implementability, and cost.

7.5 Potential Effects of Accidents

The NRC has determined that the effects of all accidents that are the most probable to occur at an ISL facility, are minor, provided that effective emergency procedures exist and are utilized in the event of an accident, and that personnel are properly trained to handle the situations. When compared with conventional underground and open pit mining methods, accidents associated with ISL uranium production typically have far less severe consequences. An assessment of potential accidents are discussed in the following sections.

7.5.1 Potential Chemical Risks

In general, most ISL facilities utilize hazardous chemicals during the extraction process to process wastewater and during restoration of groundwater quality. Several hazardous chemicals will be used in the project ISL process. Bulk hazardous chemicals will be stored on-site in areas at a distance that will pose no significant hazard to the public or workers' health and safety. Powertech (USA) will have strict standard operating procedures regarding receiving, storing, handling, and disposal of hazardous chemicals to ensure the safety of the public and workers. Industrial safety aspects associated with the use of these hazardous chemicals will be regulated by several agencies including the EPA, SD DENR and OSHA.

Process-related chemicals stored on-site will include anyhydrous ammonia, carbon dioxide, hydrogen peroxide, oxygen, sodium carbonate and sodium chloride, sodium sulfide, and sulfuric acid. Risk assessments completed by the NRC in NUREG-6733 for ISL facilities identified anhydrous ammonia and bulk acid (sulfuric and hydrochloric) storage as the most hazardous chemicals with the greatest potential for impacts to chemical safety.

The largest potential health and safety impact would result from an accidental release of these chemicals. Releases of these chemicals at levels greater than the reportable quantity level under the Community Right to Know Act (40 CFR 355) will be reported to the National Response Center, US EPA, SD DENR, and NRC. Specific quantities or uses of chemicals that require certain controls, procedures, or safety measures are defined by statutes:

- 29 CFR Part 1910.119 and 1910.120
- 40 CFR Part 68, 302.4, and 355

Compliance with these necessary requirements will reduce the likelihood of a release. Offsite potential impacts would be SMALL, while impacts to workers involved in response clean up could receive MODERATE impacts that would be mitigated by implementing procedures and training requirements (NUREG-1910, 2008).

Restoration activities will at times overlap with some operational activities such as operation of well fields, wastewater treatment, and disposal. The potential occupational health and safety impacts are expected to be less than operational impacts due to the absence of some operational activity, such as yellowcake drying operations and IX.

7.5.2 Potential Groundwater Contamination Risks

Horizontal and vertical lixiviant excursions have the potential to contaminate the groundwater in the production aquifer or the overlying or underlying aquifers.

7.5.2.1 Potential Recovery Solution Excursions

Potential groundwater quality impacts from leach fluid excursions are discussed in detail in Section 7.2.5.3. Leach fluid excursions have the potential to contaminate adjacent non-exempt aquifers with constituents that have been mobilized during the ISL process. There are two types of excursions: vertical and horizontal. A vertical excursion is movement of solution into overlying or underlying aquifers. A horizontal excursion is a lateral movement of leach fluids outside the production zone of the orebody aquifer.

The potential impacts of horizontal and vertical excursion could be significant. Monitoring wells will be installed within and around the production zone to ensure timely detection of horizontal excursions. Monitoring wells will be installed in the overlying and underlying aquifers to ensure timely detection of vertical excursions.

7.5.3 Potential Well Field Spill Risks

The failure of a process pipeline within the well field could result in the discharge of pregnant or barren lixiviant to the surface. In order to minimize the amount of process fluid that is lost should a failure occur, high and low pressure alarms and shutoffs as well as flowmeters will be installed on pipelines between the well field and the CPP. Should a failure occur and the amount and/or concentration of the process fluid lost constitute an environmental concern, then the affected area would have the contaminated soil surveyed and removed for disposal. Pipeline failure is minimized by burying the pipeline two to five feet below ground surface and inspecting and testing the piping prior to burial. Pressure test results for the piping will be documented. Corrosion free high density polyethylene (HDPE) or similar piping will be used to further reduce the chance of pipeline failure.

Small leaks at pipe joints and fittings in the header houses or at wellheads may occur occasionally. These leaks may drip process solutions onto the underlying soil until they are identified and repaired. Powertech (USA) will implement a program of continuous well field monitoring by roving well field operators including periodic inspections of each well, in order to identify and remedy small leaks. Small leaks rarely result in contamination of the underlying soil. Following repair, Powertech (USA) will survey the affected soil for contamination, and, if contamination is detected, the soil will be appropriately removed.

7.5.4 Potential Transportation Accident Risk

All shipments to and from the PAA will be transported by only licensed and certified commercial drivers and subject to both federal and state transportation regulations. Four classifications of shipments will be sent or received during pre-operational and operational phases of the project:

1. Non-radioactive materials such as: Construction materials, office supplies, process chemicals, other related materials from vendors concerning onsite activities.
2. Shipments of loaded resin to the CPP and eluted (stripped) resin to SF's.
3. Shipments of dried and packaged yellowcake to a conversion facility.
4. Shipments of waste material to an appropriate licensed facility.

Potential impacts would differ according to material type, quantities, and concentrations. The separate scenarios are discussed below. The following section discusses the transportation risks of the four materials classified above.

7.5.4.1 Potential Accidents Involving Yellowcake Shipments

The yellowcake will be transported in 55-gallon (208-L) drums to a conversion facility in Metropolis, Illinois or Port Hope, Ontario, Canada, for refining and conversion. A specialized third party transportation company (such as Tri-State freight service) will transport the yellowcake from the project to a conversion facility rather than Powertech (USA). Specific routes are to be determined upon agreements made within the transportation companies' contract. This company will meet all safety controls and regulations promulgated by 10 CFR 71.5. With a production rate of 1,000,000 lbs per year at the Proposed Action Area, shipments are estimated to weigh approximately 40,000 lbs per load and would require an estimated 25 shipments per year. Smaller or partial loads could require additional shipments.

According to NUREG/CR 6733 earlier analyses concluded that the probability of a truck accident, involving the transport of yellowcake, for any given year was 11 percent for each uranium extraction facility. This calculation used average accident probabilities (4.0×10^{-7}/km rural interstate, 1.4×10^{-6}/km rural two-lane road, and 1.4×10^{-6}/km urban interstate) that are considered conservative compared to other NRC transportation risk assessment (NUREG/CR 6733).

The worst case accident scenario involving yellowcake shipments would involve the release of yellowcake into the environment due to the breach of one or more drums containing yellowcake during transportation. In an accident involving a similar ISL facility and the shipment of yellowcake through Kansas (SRI International, 1979b), approximately 1,800 pounds or 4 percent of the yellowcake onboard the truck was spilled; no dose estimates were reported, the spill was quickly contained and all the yellowcake was thought to have been recovered.

Yellowcake shipments will be classified as Low Specific Activity (LSA) material and will be handled in accordance with NRC and DOT regulations. Powertech (USA) will develop an Emergency Preparedness Program that would be implemented should a transportation accident occur. The team training will provide technical instruction on field monitoring, sampling, decontamination procedures, communication, and other related skills necessary to safely handle a transportation emergency concerning shipments of yellowcake.

Before a shipment is approved for transportation, proper packaging including Marking/Labeling and Placarding must be accomplished within DOT regulations; Inspections of the vehicle and load will be preformed; routing the shipment to minimize radiological risk. and contacting Emergency Preparedness personnel are among the duties performed before a shipment would be approved to leave the facility.

The potential environmental impacts from the shipment of yellowcake could result from an accident and impact primarily the top soil in the area contaminated by the spill and the subsequent modification to the vegetation structure and the salvage of the top soil.

7.5.4.2 Potential Accident Involving Ion Exchange Resin Shipments

The project will have resin stripping facilities, therefore only shipments involving the barren or eluted resin will be transported to the PAA. The consequences are likely to be lower for trucks transporting barren or eluted resin because the risk of contamination is minimal. Both barren and eluted resin shipments will be handled in accordance with NRC and DOT regulations. The same general shipping procedures outlined for the shipment of yellowcake (Section 7.5.4.1) will be followed for resin shipments.

The IX resin will be shipped to and from the project in a tank truck. The NRC calculated the probability of an accident involving a truck transporting uranium-loaded resin from a SF to a CPP at 0.009 in any year (U.S. Nuclear Regulatory Commission, 1997a).

The potential environmental impacts from an accident involving the shipment of IX resin could impact primarily the top soil in the area contaminated by the spill and the subsequent modification to the vegetation structure and the salvage of the top soil. This is scenario would only take place if drums were ruptured.

7.5.4.3 Potential Accidents Involving Shipments of Process Chemicals and Fuels

Over the course of the operational life of the facility a number of shipments of chemical, fuel, and supplies will be made each week. Process chemicals delivered to the project site will include carbon dioxide, oxygen, salt, soda ash, barium chloride, hydrogen peroxide, sulfuric acid, hydrochloric acid, caustic soda (sodium hydroxide) and fuel. All applicable DOT hazardous materials shipping regulations and requirements will be followed during shipment of process chemicals and fuel to prevent a possible transportation accident. Analyses of documented accidents involving shipments have shown that secure containers have prevented spills (NMA, 2007).

7.5.4.4 Potential Accidents Involving Radioactive Wastes

The disposal of all solid 11e.(2) byproduct waste generated during operations will be transported to an appropriately licensed disposal facility. Most of the solid waste shipping will occur during the site reclamation and decommissioning stage. The probability of an accident while transporting 11e.(2) waste for any given trip is similar to the probability discussed in Section 7.5.4.1. The potential risks, however, for exposure are less because 11e.(2) waste is generally less radioactive than dried yellowcake and much of the waste will consists of solid material that in the event of an accident would be easy to contain. All applicable DOT shipping regulations and requirements will be followed before and during shipment of 11e.(2) wastes to prevent a possible transportation accident.

7.5.5 Potential Natural Disaster Risk

NUREG/CR 6733 evaluates potential risks associated with ISL facilities for the release of radioactive materials or hazardous chemicals due to the effects of an earthquake or tornado strike. The NRC determined that in the event of a tornado strike, chemical storage tanks could fail resulting in the release of chemicals. NUREG-0706 analyzed the risk from a tornado strike, which determined that ISL facilities were not designed to withstand tornado strength winds and assumed that an inventory of 45,000 kg of yellowcake was present on-site and that 15 percent (11,400 kg) or 26, 55-gallon drums of the yellowcake was dispersed by the tornado. The model assumes that all the yellowcake was in a respirable form and was carried by the tornado to the project's site boundary. According to the model, the maximum 50-yr. dose to an individual's lung would be 8.3×10^{-7} rem and located approximately 2.5 miles from the mill. NUREG-6733/CR concluded that the risk of a tornado strike on an ISL facility was very low and that no design or operational changes were necessary to mitigate the potential risks, but that it was important to locate chemical storage tanks far enough from each other to prevent contact of reactive chemicals in the event of an accident.

The NRC determined that the radiological consequences of materials released and dispersed due to earthquake damage at an ISL facility were no greater than for a tornado strike. NUREG-0706 determined that mitigation of earthquake damage could be attained following adequate design criteria. NUREG/CR-6733 concluded that risk from earthquakes is very low at uranium ISL facilities and that no design or operational changes were required to mitigate the risk, but that it was important to locate chemical storage tanks far enough from each other to prevent contact of reactive chemicals in the event of an accident.

7.6 Potential Economic and Social Effects of Construction and Operation

The following section highlights potential socioeconomic impacts of the project to Custer and Fall River Counties. A cost benefit analysis for the project is presented in section 9.0.

7.6.1 Construction

Assuming a peak workforce of about 86 payrolled employees, the influx of workers is expected to result in a small to moderate impact in Custer and Fall River Counties because of the short duration of construction phase (18-24 months) and the small size of the workforce compared to the regional labor pool of 9,202 people working full and/or part-time jobs (SD-REAP, 2008). The impacts of worker influx will be mitigated by preferentially sourcing the labor force from the within the surrounding region.

Table 7.6-1 shows the potential direct, indirect and induced effects on Custer and Fall River Counties' employment. The direct employment effects refer to the employment directly generated by the project. For the initial construction phase in years 2009 to 2010, the IMPLAN model estimated 171 additional non-payroll workers hired in Custer and Fall River Counties based on the estimated 86 payroll workers engaged directly in construction activities and the $45.8 million in non-payroll capital expenditures incurred by the project per year.

Table 7.6-1: Employment Effects of the Project in Custer and Fall River Counties

Years	Employment			
	Direct	Indirect	Induced	Total
2009-2010	86	45	126	257
2011-2017	84	36	35	155
2018-2024	18	3	3	24

Potential indirect effects pertain to the inter-industry effects from the direct effects and could include increased labor demands, goods and services required to support the ISL project (e.g. retail and restaurant staff). In addition, new workers living within Custer and Fall River

Counties would spend their income locally, which would induce additional income and employment. The sum of potential direct, indirect and induced effects represents the total potential employment impacts of the project.

These results indicate that the project has the potential to create a total of 257 jobs during the construction stage.

7.6.2 Operation Workforce

Assuming an operation phase workforce of about 84, the influx of workers is expected to result in a small to moderate impact in Custer and Fall River Counties, because of the small size of the workforce compared to the regional labor pool of 9,202 people working full and/or part-time jobs (SD-REAP, 2008). The impacts of worker influx will be mitigated by preferentially sourcing the labor force from the within the surrounding region.

For the operation phase of the project (2011-2017), the IMPLAN model estimated 71 additional non-payroll workers will be hired in Custer and Fall River Counties based on the estimated 84 payroll workers engaged directly in the operation activities and the $21.2 million in non-payroll capital expenditures incurred by the project per year. The economic impacts of these newly created 155 jobs during the operation phase of the project are not limited to Custer and Fall River Counties, but will likely affect the surrounding Counties of Weston, Niobrara, and Pennington because of increased commerce and capital exchange within the region.

7.6.3 Effects to Housing

Because of the project's close proximity to the more populated communities of Custer and Hot Springs, South Dakota and Newcastle, Wyoming with a combined population greater than 9,000 people, it can be assumed that much of the workforce would come from these localities. The remaining workforce would likely relocate from the surrounding area (e.g., South Dakota, Nebraska and Wyoming). The IMPLAN model results show that during the two year constructional stage 2010-2012, the project has the potential to sustain the creation of 257 new jobs for two years. During the following seven year operation stage the project has the potential to sustain the creation 155 jobs for seven years, and 24 jobs over the final seven years.

In the unlikely event that the entire direct payroll and non-payroll workforce relocated to Custer and Fall River counties, the population increase for the three stages of operations would be 619, 374 and 58, based on the average family size in South Dakota of 2.41 as of 2006. This increase in population would account for an increase of 6.9 percent (total population 15248) in the total population of Custer and Fall River counties. This is a very conservative estimate because it is likely that a large percentage of the workforce for operation and reclamation will be sourced from the existing workforce, thereby reducing the total population increase substantially. The potential impacts associated with an increase in population are expected to be dispersed because of the remoteness of the project site and the phased nature of construction, operation and reclamation. While this is a moderate increase in the overall percentage of the local population, this influx of immigration could be partially mitigated by implementing a preferential hiring scheme and using regional educational/training institutions to help train workers and to ensure that as many of the local residents are hired as possible.

7.6.4 Effects to Services

There are several schools located within Custer and Fall River Counties. The Custer School District includes: Custer Elementary, Hermosa Elementary, Fairburn Elementary, Spring Creek Elementary, Custer Middle, and Custer High School. Total enrollment for the Custer School District is 991 students with a student to teacher ratio of 12.1 to 1. The Hot Springs School District includes: Hot Springs Elementary, Hot Springs Middle and Hot Springs High School. Total enrollment for the Hot Springs School District is 873 students with a student to teacher ratio of 12.9 to 1. The Edgemont School District includes: Edgemont Elementary, Edgemont Junior High and Edgemont High School with a total enrollment of 138 students and a student to teacher ratio of 8.8 to 1.

Families moving into the aforementioned school districts near the project site as a result of the project are not expected to strain the current school system because they presently under-capacity as shown by the combined student teacher ratio for the three school districts of 12.1:1 as compared to the State wide student teacher ratio of 13.4:1 and the national average of 15.7:1.

The costs associated with increased demand of public facilities and services are expected to be minimal. The need for additional water supply and waste disposal facilities are expected to be minimal based on adequate existing capacity. Existing emergency response and medical treatment facilities are capable of responding to any possible incident at the project site; therefore the basic services required to support the project already exist. Since the majority of the workforce will be local there are no significant changes or stresses anticipated for other public services, such as police, health care, or utilities.

7.6.5 Effects to Traffic

There are only a few residences in the vicinity of the proposed project. Most of the land in the surrounding a 2 km radius of the project is devoted to rangeland. Other land uses include grazing, crop land, hunting and wildlife habitat. As a result of the low population density of the area surrounding the project site, the anticipated limited use of large machinery and vehicles and the infrequent movement of transport vehicles to and from the project site, no significant noise or congestion impacts are anticipated within the surrounding 2 km area during operations. There will be some increased traffic, noise and dust on the county road between the project site and Edgemont during construction activities. However, these potential impacts will be of short duration.

7.6.6 Economic Impact Summary

According to the Cost-Benefit Analysis in Section 9, the most significant benefits of the project are its potential to sustain the creation of 257 new jobs during construction, 155 jobs during operation, and 24 jobs during reclamation, all of which include the direct, indirect and induced effects on the local economies. In addition, an estimated $91.6 million during construction will be spent on non-payroll expenditures, $148.4 million during operation and 14.0 million during reclamation; and approximately $35.1 million in state and local tax revenue and $186.7 million in value added benefits are expected to be generated over the life of the project (Table 7.6-2) as a result of the project.

Table 7.6-2 summarizes the associated short-term and long-term cost of the proposed project. Impacts to the regional housing market should be minimal because of the large percentage of local workers, impacts to schools and public facilities should be negligible because of their present ability to absorb any associated regional influx, and the impact of noise and additional traffic presents little or no change compared to the no action alternative. Due to the remote location of the project Site and minimal surface disturbance, impacts to recreational activities and aesthetic values within the area should be negligible.

This CBA indicates that the construction and operation costs including capital costs of this project will result in positive economic benefits to the local and regional economy by the creation of hundreds of jobs and millions of dollars in tax revenue over the life of the project. The development the ISL project should present Custer and Fall River counties with net positive gain when compared to the no action alternative.

Table 7.6-2: Summary of Benefits and Costs for the Project

Benefits	Costs
▪ **Value Added** $186,697,204 ▪ **Tax Revenue** $35.1 million ▪ **Potential to create temporary and permanent jobs** 257 jobs over two years (2009-2010) during construction 155 jobs over seven years (2011-2017) during operation 24 jobs over seven years (2018-2024) during reclamation ▪ **Increased knowledge of the local environment and natural resources**	▪ **Housing Impacts** Little or no change ▪ **Schools and Public Facilities** Negligible ▪ **Noise and Congestion** None ▪ **Impairment of Recreation and Aesthetic Values** Negligible ▪ **Land Disturbance** Minor ▪ **Groundwater Impacts** Controlled through mitigation ▪ **Radiological Impacts** Controlled through mitigation

7.7 Environmental Justice

The U.S. Census 2000 Decennial Population program provides information about race and poverty for the area surrounding the ISL project. The 2000 Census data for South Dakota was used to compare the demographic data for the counties surrounding the PAA. These data were also used to determine if there was a disproportionate percentage of minorities or low-income populations that might be affected by the ISL project relative to the State.

As shown in Table 7.7-1, minorities make up less than six percent of the total population for Custer and Fall River Counties, much less than the state average of more than 11 percent and no concentration of minorities was identified to reside near the PAA; therefore, no disproportionate impacts could occur to minority groups.

Per capita income level based on 1999 dollars was 17,945 for Custer County and $17,048 for Fall River County; these numbers are near the State average of $17,562. The median income in 2000 was $36,303 for Custer County and $29,631 Fall River compared with $35,282 for the State average, all well above the 2006 poverty level of $20,614 for a family of four family member household. The poverty rate in Custer County was 9.4 percent and 13.6 percent in Fall River County. Compared to the state-wide average of 13.2 percent, Fall River's poverty rate is only slightly higher, while Custer County is well below the state-wide; therefore, there is not be a disproportionate concentration of low-income populations within the study area compared to the State as a whole.

It is possible that some low-income individuals or minorities may reside within the study area, but not disproportionately compared with the state-wide averages. Also, since the proposed project is not expected to generate any adverse environmental impacts to the area's natural resources, there will not be any disproportionate environmental consequences to minority groups or low income populations.

Table 7.7-1: Project-Area Housing Unit Statistics - 2000

Housing Unit Type	Custer County SD Units	Custer County SD % of Total	Fall River County SD Units	Fall River County SD % of Total	Niobrara County WY Units	Niobrara County WY % of Total	Weston County WY Units	Weston County WY % of Total
Total housing units	3624	100%	3812	100%	1338	100%	3231	100%
Single family homes	2358	65.0%	2429	63.7%	1096	81.9%	2186	67.6%
Multi-unit housing	261	7.2%	568	14.9%	104	7.8%	203	6.3%
Mobile homes	990	27.3%	807	21.2%	133	9.9%	823	25.5%
Other (boat, RV, van, etc.)	15	0.4%	8	0.2%	5	0.4	19	0.6%
Rental units	615	17.0%	901	23.6%	222	16.7%	549	17.0
Owner-occupied vacancy	-	2.3%	-	4.8%	-	7.5%	-	4.8%
Rental vacancy	-	9.1%	-	9.6%	-	18.2%	-	12.0%
Seasonal / recreational / occasional use vacancy	-	10.1%	-	7.5%	-	4.7%	-	4.4%
Units lacking complete plumbing	26	0.9%	47	1.5%	17	1.7%	11	0.4%
Units lacking complete kitchen facilities	51	1.7%	49	1.6%	4	0.4%	13	0.5%
No telephone service	77	2.6%	123	3.9%	44	4.4%	113	4.3%

Data from US Census Bureau, Census 2000 Summary File 3 Dataset.

7.8 References

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8.0 Alternatives to Proposed Action

8.1 No-Action Alternative

Under the provisions of the National Environmental Policy Act (NEPA), one alternative that must be considered in each environmental review is the no-action alternative. In this case, the no-action alternative would be to not build or license the Dewey-Burdock ISL facilities. This alternative will provide a baseline from which to compare the potential impacts of the other action alternatives.

8.1.1 Potential Impacts of the No-Action Alternative

The potential impacts of the no-action alternative include, the lost opportunity to produce a large resource of energy production supply. In addition beneficial impacts resulting from stimulated economic growth, income and tax generation will not be realized. The proposed project represents a significant new source of domestic uranium supplies that are essential to provide a continuing and economic source of fuel to power generation facilities. As discussed in the Cost-Benefit Analysis, Section 9, the Dewey-Burdock Project is expected to provide a significant beneficial economic impact to the local economy.

8.2 Proposed Action

While the PAA encompasses 10,580 acres (4,282 ha), the land potentially impacted by the Proposed Action would be approximately 68 acres (27 ha) (facilities, piping, ponds, well fields and roads) in year one, and the potential impacts will be intermittent. The average disturbance per year for the life of the proposed project (production to restoration) is estimated at 77 acres (31 ha). If the maximum area for land application of treated wastewater is included in the footprint of the Proposed Action, then approximately 384 acres (155 ha) would be affected per year on average during the life of the mine. During the first year of the Proposed Action, approximately 110 acres (44 ha) would be affected. A description of the proposed ISL facilities is provided in Section 3.1.

8.3 Reasonable Alternatives

8.3.1 Location of Proposed Facilities

Locations of the proposed CPP and the SFs were strategically chosen based on specific site area, proximity to historical and current reserves within the northern Dewey and southern Burdock areas, environmental both historical disturbance, wildlife concerns and the geology of the area.

The CPP would be constructed in Section 2, T7S, R1E of the Burdock action area and the SF would be located in Section 29, T6S, R1E of the Dewey action area (see Figure 3.2-1).

- Based on the TVA data and current Powertech (USA) data, the location of both the CPP and the SFs locations would be approximate to the center of ore reserves located within the action areas in locations that have little potential for ore beneath chosen locations.
- Environmental considerations were noted such as historical surface mines, nesting sites for raptors, drainage issues; the locations chosen do not have these issues.
- There were no issues with the surface or subsurface geology for either the CPP or the SF location.

8.3.1.1 Well Fields and Monitoring Wells

A well field consists of ISL amenable ore zones within a sandstone bounded by an upper and lower hydrologic barrier. In the simplest scenario, there is a single ore zone; and a monitor well ring radially bounds that ore zone, as one of the primary means of ensuring control of leach fluids within a well field. In more complex systems, there may be more than one ore zone stacked vertically within a sandstone, and there may be more than one sandstone, with multiple ore zones stacked vertically (Lost Creek Project, 2007).

Within the Dewey area, there exists at least one area where one production zone overlies another. There will be different scenarios concerning well completions within this type of well field. The monitoring well rings proposed will be relatively small due to the fact that the well fields will contain approximately one million pounds of reserves. The basic scenario for well completion would be completing the production, injection and monitoring wells within the one sand that contains the ore. A more complex scenario of well completion would exist for the area(s) that contain more than one ore bearing sand. In this case, the production and injection wells will be completed within the lowest ore bearing sand. After the ore has been recovered in the lowest sand, the production and injection wells will be completed in the next ore bearing sand upward. Upon recovering the ore from all ore bearing sands, restoration will commence in the reverse order by restoring the uppermost horizon sand's first and work down to the lowermost horizon sand(s). The monitoring well ring design will conform to open intervals corresponding to the depths of each sand adjacent to each well. This type of completion is preferred over other completion methods such as:

- Multiple Completions

  Completion of wells across multiple sands within the same horizon, using the same wells and the same monitor ring could be an alternative. However, this is not considered an appropriate alternative because of the difficulties of ensuring the injection and production fluids are being efficiently distributed to the various sands in the horizon and of monitoring the performance of the well field.

- Larger Rings Encompassing More Reserves

  The wells are completed in the same manner as the preferred option. Because of the increase in scale, the construction time, evaluation of pump tests, and all other activities associated with installing and producing the well field would increase dramatically. Final restoration/reclamation of the well field would be delayed until all operations for the area were complete. Therefore, this option is not considered the most efficient approach (Lost Creek Project, 2007).

8.3.2 Process Alternatives

8.3.2.1 Lixiviant Chemistry

Powertech (USA) proposes to use gaseous oxygen and carbon dioxide to dissolve the uranium in the ore zone. Alternatives for lixiviant chemistry include ammonium carbonate or sodium bicarbonate/carbonate solutions and acidic leach solutions. While these lixiviant solutions have been used in previous ISL operations, they were rejected for the Dewey-Burdock Project, due to the fact that restoration and stabilization of groundwater to baseline conditions has been shown to be more difficult with these alternative systems.

8.3.2.2 Groundwater Restoration

The proposed groundwater restoration method for the proposed project is based on the successful programs implemented by other projects such as the Cogema Irigaray Restoration Project or Crow Butte Resources, Inc., which have both received regulatory approval for successfully restoring groundwater to previous class of use.

It is anticipated that a combination of three restoration phases and technologies will be utilized to restore groundwater. These include groundwater sweep, groundwater treatment and reductant addition (biological or chemical). Phase 1, groundwater sweep involves continued pumping of the production wells (injection of lixiviant is stopped) which results in an influx of uncontaminated groundwater from outside the well field. Phase 2, groundwater treatment involves pumping water from the well field, treating it with reverse osmosis and re-injecting the purified permeate stream into the well field. Phase 3, if necessary, involves the introduction of chemical reductants into the injection stream to stimulate the natural bacteria and to further reduce metals to an insoluble state.

An alternative groundwater restoration method includes the use of bioremediation. Bio-reductants are introduced to invigorate natural bacteria that re-reduce metals to an insoluble state. Bio-reduction has been used successfully to restore the Sweetwater Pit Lake, which originally had uranium concentrations of 8 to 10 mg/L and post remediation the levels were below 5 mg/L. This alternative was considered but eliminated because the effectiveness of this technology is not well documented for aquifer remediation post ISL operations as discussed in NUREG-1910.

8.3.2.3 Waste Management

There are several disposal options for the liquid waste generated during the production and restoration process including brine concentrators, discharge to surface waters, evaporation ponds, waste disposal well, land application, and waste disposal well off-site. The National Pollutant Discharge Elimination System (NPDES) permitting process allows for the discharge of treated liquid effluents to surface waters that meet state and federal water quality standards, but was determined to be a poor use of water resources in a water sensitive region. The sole use evaporation ponds was rejected because of the large surface impoundment area that would be required to evaporate the daily bleed water and the severe winters that would freeze the ponds for several months out of the year, thereby decreasing the evaporation rates. The transportation of liquid waste for disposal at an off-site deep well is one consideration being explored to handle the CPP waste. Powertech (USA) considers the use of waste disposal well and/or land application as the best alternatives to dispose of these types of liquid waste. The deep well(s) identified by Powertech (USA) will isolate liquid waste generated during the production and restoration processes from any underground source of drinking water (USDW); in the case of land application the bleed stream will be treated with additional IX to remove residual uranium, followed by contact with barium chloride to remove radium. Other treatments may also be required before the bleed stream will then be applied to the land through center-pivot irrigation systems to grow an agricultural crop.

Fresh water consumed during drilling, road maintenance, and other related activities will be disposed of appropriately.

Non-radioactive solid and liquid waste will be managed in accordance with existing regulations and disposed of in a landfill that has been permitted under subtitle D of RCRA. Materials that cannot be decontaminated will be disposed of at a licensed 11e.(2) disposal facility.

8.4 Eliminated Alternatives

As part of the alternatives analysis conducted by Powertech (USA) conventional uranium mining both open-pit and underground combined with milling were considered. However, due to economic, environmental, and recovery issues, a detailed analysis was not carried forward at this time.

8.4.1 Open Pit Mining Alternative

Open pit mining requires the removal of all material covering the orebody (overburden) and then the ore itself: The ore would then be transported to a conventional mill for further processing and extraction through grinding, leaching, purifying, concentrating, and drying. From an economic point of view, open pit mining of the relatively low grade and depth of the Dewey-Burdock ore bodies would require a much larger investment than ISL, especially in the early phase, when a significant investment would be required for acquisition of heavy equipment to perform the earthwork to expose the orebody. The overall footprint of the operation would be larger because of greater manpower and material handling requirements. Waste rock piles from excavation of the overburden and the mine pit would make permanent changes to the topography, with a disturbed area approximately three times the area of the orebody mined, in order to maintain slope stability. Potential personnel injury rates and potential radiological exposures at the PAA would also be higher with open pit mining than what would be experienced with ISL. A mill tailings pond would be required to contain the millions of tons of waste produced from the uranium mill'. This tonnage would represent a large volume of radioactive tailings slurry covering a large area of ground surface. Conventional mill operation would involve higher risks of spillage and radiological exposure to both personnel and the environment than those associated with the proposed ISL operations. Open pit mining at the Proposed Action Area would also require dewatering of the pit to depress the potentiometric surface of all aquifers. Large quantities of groundwater would be discharged to the surface. Some of this groundwater contains naturally elevated radium-226 (Ra-226), radon, and uranium, which would have to be treated before discharge and the residue disposed of as radioactive solid waste (Lost Creek Project, 2007).

8.4.2 Underground Mining Alternative

Underground mining of the uranium resources at the Permit Area would involve sinking of shafts to the vicinity of the ore bodies, horizontally driving crosscuts and drifts to the ore bodies at different levels, physically removing the ore and transporting the mined ore to the conventional mill for further processing. Processes for milling and uranium extraction from underground mined ores would be the same as those for ores mined from the open pit. When one considers the alternative of underground mining, the economic and environmental disadvantage closely parallel those of an open pit mine. These, as stated above, include large amounts of initial investment, permanent changes to the topography (though in a smaller scale than open pit mining because less amounts of waste rock are being generated), generation of a significant amount of mine tailings, increased risks of injury and potential exposure to radioactive materials during mining and milling, and surface discharge of groundwater from mine dewatering with elevated radionuclide concentrations. One major concern for underground uranium mining is the potential exposure of miners to, radon gas if the gas is not continuously vented to the atmosphere. Subsequent land surface subsidence could also occur after the completion of underground mining.

Economic costs and potential environmental impacts associated with open pit and underground mining, clearly show that ISL is the more benign and viable uranium production method to use. The initial investment is lower; the tailings problem is completely eliminated; radiation exposure and potential environmental impacts are minimized; and the groundwater resource is preserved. In addition, because of the reduced costs, lower grade ores can be recovered through ISL than can be recovered from open pit and underground mines (Lost Creek Project, 2007).

The U.S. NRC conducted a comparison of the overall potential impacts of open pit and underground mining with ISL methods in NUREG-0925 and concluded that ISL methods generate lesser potential environmental and socioeconomic impacts. The relative advantages of ISL methods include:

- The degree and the quantity of disturbance to surface area are substantially less than with surface mining.

- No mill tailings are produced and the volume of solid waste is significantly less than conventional milling – typically more than 99 percent less waste is produced with ISL.
- The elimination of airborne emissions from overburden stockpiles or tailings stockpiles and the crushing and grinding processes, which are required for conventional mining.
- Exposure to radionuclides is markedly reduced with ISL methods because less than 5 percent of the radium in an orebody is brought to the surface compared with up to 95 percent with conventional mining techniques.
- Because of the lack of tailings and other significant sources of solid waste ISL facilities can readily be decontaminated and returned to unrestricted use within a relatively short time frame (12-15 years).
- ISL facilities typically consume much less water than conventional mining and milling, on the order of 1 percent of their production flow.
- The socioeconomic advantages of ISL include:
  - Lower grade ores can be mined
  - Requires less capital investment
  - Provides a safer working environment for the miner
  - Decreases amount of time before production begins and
  - Requires a smaller workforce

8.5 Cumulative Effects

8.5.1 Future Development

Powertech (USA) has identified other potential ore bodies near the proposed project region that may be developed. Development of these facilities is dependent upon further site investigations by Powertech (USA), as well as the viability of the uranium market. If the ore bodies and market prove to be favorable, Powertech (USA) may submit applications for permits to develop these additional resources.

8.6 Comparison of the Predicted Environmental Impacts

Table 8.6-1 outlines the predicted environmental impacts of the proposed project (Section 8.2) compared to the no-action alternative (Section 8.1), the process alternatives (8.3) and the mining alternatives (8.4). Potential environmental impacts are discussed in greater detail in Section 7.0.

Table 8.6-1: Comparison of Environmental and Socioeconomic Impacts based on Proposed Action and Alternatives

Impacts of Operation	Proposed Action	Process Alternatives		Mining Alternatives		No-Action Alternative
		Alternate Lixiviant Chemistry	Alternate Waste Management	Open-pit mining with a conventional mill	Underground mining with a conventional mill	
Land Surface Impacts	Minimal temporary potential impacts to the well field areas; significant temporary disturbance confined to a small portion of the proposed project site	Same as Proposed Action	Same as Proposed Action	Significant land disturbance with the potential for portions of the land surface to remain highly altered	Same as the open pit alternative	None
Land Use Impacts	Temporary loss of agricultural production (grazing livestock) and wildlife habitat within the PAA for the duration of the proposed project	Same as Proposed Action	Same as Proposed Action	Land disturbance increases considerably and time required for reclamation is more extensive; Entire site may not return to unrestricted use	Same as the open pit alternative	None
Transportation Impacts	Minimal impact on current traffic levels	Same as Proposed Action	Same as Proposed Action	The traffic volume elevates substantially due to increased employment and vehicle requirements and considerable more opportunity for higher radiation exposure to the public due to transporting of uranium ores over public roads.	Same as the open pit alternative	None
Geology and Soil Impacts	No geologic impacts; temporary impacts to the soils from disturbance; possible impacts to soil from land application of treated wastewater	Same as the Proposed Action	Similar to the Proposed Action with minimal temporary soil impacts in disturbance areas from wind and water erosion	No geologic impacts; more potential land disturbance due to the possibility of long-term open pit mining	Same as the open pit alternative	None
Surface Water Impacts	None	None	None	Possible contamination of surficial water could result with the use of ponds	Possible contamination of surficial water could result with the use of ponds	None
Groundwater Impacts	Slight consumption of ore zone groundwater	Similar to Proposed Action but with increased difficulty in restoring water quality to baseline conditions	Same as the Proposed Action	Ore zone aquifer will be dewatered in order to mine	Ore zone aquifer will be dewatered in order to mine	None

Table 8.6-1: Comparison of Environmental and Socioeconomic Impacts based on Proposed Action and Alternatives (cont'd)

Impacts of Operation	Proposed Action	Process Alternatives		Mining Alternatives		No-Action Alternative
		Alternate Lixiviant Chemistry	Alternate Waste Management	Open-pit mining with a conventional mill	Underground mining with a conventional mill	
Ecological Impacts	Would only disturb ~ 108 (without land application) to 463 (with maximum amount of land application) acres per year over the life of the proposed project with no substantial impact on the ecological or biological diversity	Same as the Proposed Action	Same as the Proposed Action	Similar to the Proposed Action, but considerably more time would be required for reclamation	Same as the open pit alternative	None
Air Quality Impacts	An increase of 10 tons per year of particulates due to increased traffic	Same as the Proposed Action	Same as the Proposed Action	Total dust emission would be increased significantly due to increased traffic and crushing and grinding processes	Same as the open pit alternative	None
Noise Impacts	Slight increase over background noise levels	Same as the Proposed Action	Same as the Proposed Action	Significant increase in noise levels due to explosions, excavation' and crushing and grinding of rock	Significant increase in noise levels due to crushing and grinding processes	None
Historical and Cultural Impacts	None	None	None	None	None	None
Visual/Scenic Impacts	Moderate and temporary impact; Well fields and Plants would negatively affect the aesthetics	Same as the Proposed Action	Same as the Proposed Action along with evaporation ponds that would further negatively affect the aesthetics	Large and temporary impact; open pit disturbs much more land area and requires much more heavy machinery that would negatively affect the aesthetics	Large and temporary impact; Mill, tailings pond, and increased use of heavy machinery would negatively affect aesthetics	None
Socioeconomic Impacts	Increased economic impact of $307M and the potential for 436 temporary and permanent jobs for Custer and Fall River Counties and the surrounding area	Same as the Proposed Action	Same as the Proposed Action	Similar to the Proposed Action but with an increase in economic impact and jobs created due to the larger workforce and required operation	Similar to the open pit alternative	Loss of positive economic impact of $307M along with potential for 436 temporary and permanent jobs for Custer and Fall River Counties and the surrounding area
Non-Radiological Health Impacts	None	None	None	None	None	None

Table 8.6-1: Comparison of Environmental and Socioeconomic Impacts based on Proposed Action and Alternatives (concl.)

Impacts of Operation	Proposed Action	Process Alternatives		Mining Alternatives		No-Action Alternative
		Alternate Lixiviant Chemistry	Alternate Waste Management	Open-pit mining with a conventional mill	Underground mining with a conventional mill	
Radiological Health Impacts	Estimated maximum TEDE at proposed project boundary is 12.5 mrem y^{-1} compared to the public dose limit of 100 mrem y^{-1} for the land application option; Estimated maximum TEDE at proposed project boundary is 2.5 mrem y^{-1} for the deep well disposal option.	Same as Proposed Action	Same as Proposed Action	Exposure to radioactive material is significantly increased because 95% of the radium in an orebody is brought to the surface	Same as open pit alternative	None
Waste Management Impacts	Generation of liquid and solid waste for disposal	Same as the Proposed Action, but potentially increased liquid waste due to the mobilization of additional hazardous elements in groundwater	Increased generation of 11e.(2) byproduct material for disposal	Waste generated is much greater than ISL and not all material can be removed from the site (e.g., tailings and waste rock)	Same as open pit alternative	None
Mineral Resource Recovery Impacts	Production of domestic energy resource	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Loss of domestic energy supply source; the current estimated reserves of uranium within the proposed permit area total 7.6 million pounds U_3O_8 currently valued at $456M (based on the spot market price of $60)

8.7 References

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U.S. Nuclear Regulatory Commission, "*Draft Environmental Statement Related to the Operation of the Teton Project*", NUREG-0925, June 1982. Para. 2.3.5.

9.0 Cost-Benefit Analysis

9.1 Introduction

This section has been prepared to meet the requirements established under NUREG-1569, and includes a description of the economic benefits of the proposed Dewey-Burdock Project. For the most part, benefit and cost estimates have been quantified; however, some potential environmental impacts cannot be reliably quantified and the benefit and cost estimates have been analyzed using qualitative or non-monetary terms.

The following economic analyses were created using IMPLAN (IMpact analysis for PLANning), an industry standard software used to measure the impacts due to a change in economic activity on a regional or local economy. IMPLAN was originally developed by the United Stated Department of Agriculture (USDA) Forest Service in cooperation with the Federal Emergency Management Agency (FEMA) to estimate the economic effects of proposed resource outputs on local communities. Since 1988, the Minnesota IMPLAN Group, Inc. (MIG) has managed IMPLAN for public users.

The results of the cost-benefit analysis (CBA) presented in this section establishes that the proposed project is a cost-effective project and will provide a positive economic benefit to the 50 km radius impact area and the State of South Dakota.

9.2 Alternatives and Assumptions

CBA is a standard analytical tool used to determine whether the present cost of a project will result in sufficient benefits to justify investment in a capital intensive project (Zerbe and Bellas 2006). To adequately evaluate the economic impacts of any project, the CBA needs to define the alternatives being considered and the underlying assumptions including qualities of goods, labor costs, market conditions and discount rates used to compute net present value, as well as establish the scope of impacts and non-monetary impacts.

9.2.1 Identification of Alternatives

This CBA evaluates the benefits and costs of the proposed project resulting from its future operation in Custer and Fall River counties, South Dakota. The analysis also includes a comparison of the proposed project to the no action alternative.

9.2.1.1 No Action Alternative

Under this alternative, the proposed project would not be constructed as planned. There would be no impacts to the existing environment including land and water resources at the proposed site in Fall River and Custer Counties. In addition, there would be no change to the existing underlying socioeconomic and demographic trends within the impact analysis area as positive economic benefits to local communities and the State of South Dakota would not be realized.

9.2.1.2 Proposed Action

The proposed action includes the construction and operation of a uranium in situ leach (ISL) facility. The ISL facility will utilize gaseous oxygen and carbon dioxide that are injected into the ore-body within the Inyan Kara Formation to recover the uranium which is then pumped to the surface where it is extracted and processed into the final (yellowcake) product. This proposed action involves limited surface disturbance, negligible radiological impacts with insignificant changes in the overall ground water quality at the proposed project site.

9.2.2 Key Assumptions

Key assumptions involved in the cost and benefits of the proposed project include: (1) the operating life of the proposed project; (2) the discount rate; (3) the scope of the potential impacts; and (4) non-monetary impacts. These assumptions are described in more detail below.

9.2.2.1 Operating Life of the Project

The proposed project is considered as a single unit of analysis including the sequentially developed well fields, a CPP and other ancillary facilities. For this analysis, the total operating/production life of the proposed project is assumed to be 7 years. There are three phases of operation which will be analyzed as separate units with distinct costs and benefits associated with each:

- Two years of site development and facility construction
- Seven years of well fields and CPP operations – includes continued well field construction and initiation of restoration
- Seven years of the site reclamation ground water restoration and decommissioning of well fields and ancillary facilities

9.2.2.2 Discount Rate

A cost-benefit analysis attempts to compare all applicable cost and benefits to the present value. Determining the net-present value (NPV) is calculated using a discount rate that allows for the comparison of the present value of future expenditures and allows all relevant future cost and benefits to be compared in present-value terms. A discount rate of 7.0 percent has been used for this present-value calculation as referenced in Circular A-94 from the United States Office of Management and Budget (OMB 1992). Circular A-94 was revised in 1992 based on extensive review and public comment and currently reflects the best available guidance on standardized measures of costs and benefits. This rate approximates the marginal pre-tax rate of return on an average investment in the private sector in recent years.

9.2.2.3 Scope of Impact

An important step in any cost-benefit analysis is establishing a viable scope of impact and establishing who will be affected by the proposed project (Zerbe and Bellas 2006). This analysis has been limited to the proposed project's direct zone of influence that is defined as the area within which the proposed project's impacts and benefits are reasonably anticipated to be concentrated, including the population areas most likely to contribute to the proposed project's local workforce and to provide ongoing sources of supplies and commodities during construction and operations.

The direct zone of influence required under NUREG-1569 for the proposed project's cost-benefit analysis includes a radius of 80 km (50 miles) from the center of the PAA and includes the townships, towns, and unincorporated areas within the two South Dakota counties surrounding the proposed project, Custer and Fall River. Approximately 1.5 miles (2.4 km) of the proposed project's western border follows the Wyoming/South Dakota state line south of Dewey, South Dakota. Therefore, the Wyoming locations of Newcastle and Osage[2] in Weston County are also included in the proposed project's direct zone of influence, but because the proposed project is located entirely within Custer and Fall River counties this cost-benefit analysis evaluates the proposed project's economic impact only within these two counties and the South Dakota taxes that will be levied. These locations are considered close enough to reasonably supply workers or supplies to the proposed project on a regular basis. No areas of appreciable population size were

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[2] Osage is not an incorporated town but is defined as a "CDP" or census-designated place by the USCB in partnership with State agencies. CDPs are areas of significant population outside of any incorporated municipality and that are locally identified by a name.

located within this radius (80 km) from the proposed project in other Wyoming counties or to the south in Nebraska.

Rapid City, South Dakota, the closest urban area to the proposed project is located approximately 100 miles (161 km) via highways northeast of the PAA, in Pennington County. Rapid City may serve as a regional logistics hub and source of workers and supplies for the proposed project as well. Because of its greater distance from the proposed project, Rapid City is considered to be part of the proposed project's indirect zone of influence. Two other communities in Pennington County also fall within the proposed project's indirect zone of influence, Hill City and Keystone.

9.2.2.4 Non-monetary Impacts

A conventional CBA uses monetary values to compare goods and services derived from a project or program. The value of goods and services represent their relative importance. If the project's total value of the benefits is greater than the total value of the costs, then it is beneficial. While many inputs in the project CBA are goods and services that are traded in markets at established and well-known prices such as, skilled labor, construction material, and gasoline, other inputs are not directly traded and are more difficult to value (Zerbe and Bellas 2006). These inputs such as, changes to land or water resources, or aesthetic impacts have been assigned a qualitative value based on the best available information.

9.3 Economic Benefits of Project Construction and Operation

This section evaluates the potential economic impacts of construction and operation-related activities over the life of the proposed project. Economic benefits created from the proposed project include the number of jobs created and local and state tax revenues generated and other activities that have the potential to favorably affect the local economy.

This analysis uses IMPLAN as previously described to calculate the potential economic impacts to Custer and Fall River Counties. IMPLAN can tailor the input-output models according to specific regional or community data and the program can analyze the impacts from more than 500 different types of industries for counties throughout the United States. In order to analyze the impacts of the proposed project on the local economies affected, the proposed project's industry classification has been identified as mining and construction. The model also requires labor and capital expenditures as inputs in order to evaluate the potential economic impacts of the proposed project. The outputs calculated are the potential direct, indirect and induced employment impacts and tax revenues generated.

The surrounding counties of Custer and Fall River, South Dakota were analyzed using the two industry sectors most closely associated with the stages of development to of the proposed project: construction (IMPLAN code 41) and support activities for mining (IMPLAN code 29). IMPLAN does not have a specific uranium mining sector associated with Custer and Fall River counties, so all tax revenue estimates are considered as an approximation given that ad valorem and severance taxes will likely differ for different mining sectors.

9.3.1 IMPLAN Input Data

For this analysis the initiation of the construction stage of the proposed project assumes a start date of 2009 continuing through 2010. Table 9.1-1 shows the input data for construction, operation and reclamation expenditures over the life of the proposed project. The total estimated number of construction workers directly involved in construction is 86. The total non-payroll capital construction expenditures are estimated at $45.8 million per year and $21.2 million per year for operation expenditures and $2.0 million per year for reclamation expenditures.

Upon completion of the well fields and CPP, the operation will employ approximately 84 full-time employees over the following 7 year period and approximately 18 employees during the final 7 years of restoration and reclamation. It is likely that many of these employees will come from Custer and Fall River counties.

Table 9.3-1: Input Data for the Project

Activities	IMPLAN Code	Per Year		
		Year 1–Year 2	**Year 3–Year 10**	**Year 11-Year 18**
Construction Expenditures				
Non-payroll	41	$45.8 M	N/A	N/A
Payroll	41	86 Workers $3.5 M	N/A	N/A
Operation Expenditures				
Non-payroll	29	N/A	$21.2 M	$ 2.0 M
Payroll	29	N/A	84 Workers $5.6 M	18 Workers $1.0 M

9.3.2 Employment Benefits

Using the Input Data from Table 9.3-1, IMPLAN can generate the potential employment-related effects of the proposed project. IMPLAN defines employment as total wage and salary employees, including self-employed jobs that are related to the proposed project. It also includes both full-time and part-time workers and is measured in annual average jobs.

Table 9.3-2 shows the potential direct, indirect and induced effects on Custer and Fall River Counties' employment. The direct employment effects refer to the employment directly generated by the proposed project. For the initial construction phase in years one to two, the model estimated the potential for an additional 171 non-payroll (indirect and induced) workers that could be hired in Custer and Fall River Counties based on the 86 payroll workers engaged directly in construction activities and the $45.8 million in non-payroll capital expenditures incurred by the proposed project per year.

Table 9.3-2: Employment Effects of the Project in Custer and Fall River Counties

	Employment			
Years	**Direct**	**Indirect**	**Induced**	**Total**
1 - 2	86	45	126	257
3 - 10	84	36	35	155
11 - 18	18	3	3	24

Potential indirect effects, which pertain to the interaction of local industries (direct effects) purchasing from local industries could include increased labor demands, goods and services required to support the proposed project (e.g. retail and restaurant staff). In addition, new workers living within Custer and Fall River Counties would spend their income locally, which would induce additional income and employment. The sum of potential direct, indirect and induced effects represents the total potential employment impacts of the proposed project.

These results indicate that the proposed project has the potential to create a total of 257 (including 86 Powertech (USA) employees) jobs during the construction stage and a total of 155 (including 84 Powertech (USA) employees) jobs during the operation stage and 23 (including 18 Powertech (USA) employees) jobs during the reclamation stage of the proposed project. The economic impacts of the proposed project will not limited to Custer and Fall River Counties, but will likely benefit the surrounding Counties of Weston, Niobrara, and Pennington because of increased commerce and capital exchange within the region.

9.3.3 State and Local Tax Revenue Benefits

In addition to the employment benefits of the proposed project, IMPLAN can calculate the expected State and Local taxes generated over the life of the proposed project. In order to remain consistent with the scope of impact, Federal taxes are not included in this analysis. The results presented in Table 9.3-3 are standardized to 2008 dollar equivalents using the OMB recommended real discount rate of 7.0 percent.

Potential state and local tax revenue associated with the proposed project are presented in Table 9.3-3. Only indirect business taxes, which include excise taxes, property taxes, fees, licenses, and sales taxes that stem directly from the construction and operation of the proposed project and paid by Powertech (USA) are presented instead of the tax revenue generated from employee or employer social insurance taxes, which represent only a transfer of wealth rather than a net economic gain when compared to the no action alternative.

As shown in Table 9.3-3, the results from the IMPLAN analysis indicate that the construction, operation and reclamation stages of the proposed project are expected to generate a net present value of approximately $13.54 million in total business tax revenue over the life of the proposed project. The total enterprise (corporate) tax was not analyzed because South Dakota does not levy a Corporate Income tax.

Table 9.3-3: IMPLAN Projections of State and Local Tax Revenue

	Construction 2 years	**Operation 7 years**	**Reclamation 7 years**	**Total**
Indirect Business Tax Revenue	**Net Present Value ($)***			
Motor Vehicle License (per annum)	$10,800	$6,107	$552	
Other Taxes (per annum)	$51,351	$29,037	$2,627	
Property Tax[1] (per annum)	$334,485	$334,485	$334,485	
State/Local Non Taxes (per annum)	$28,602	$16,173	$1,463	
Sales Tax[2] (per annum)	$1,374,000	$636,000	$60,000	
Total Indirect Business Taxes per Year	$1,799,238	$1,021,802	$399,127	
Total Indirect Business Taxes	$3,598,476	$7,152,614	$2,793,889	**$13,544,979**

*2008 Dollar Equivalents
[1]Property Tax was calculated using the value generated by the IMPLAN model for construction, $334,485.
[2]Sales Tax was calculated by applying 3% to the total non-payroll expenditures

In addition to the business tax revenues, the State of South Dakota, Special Tax Division of the Department of Revenue and Regulation levies a uranium severance tax of 4.5 percent as well as 0.24 percent conservation tax on the taxable value of any energy mineral produced from mining operations (South Dakota Department of Revenue and Regulations – Special Tax Division 2008). Current resource estimates for the proposed project are 7.6 million lbs. (43-101 compliant). A total reserve estimate has not been included because it is still incomplete. Assuming that the identified 7.6 million lbs were sold at current market prices of approximately $60 per pound, the severance tax would yield approximately $20,520,000 in net economic benefits over the life of the operation, 50 percent of which would be collected by the counties, and an additional $1,094,400 for the conservation tax. The total taxes generated over the lifetime of the proposed project, including indirect business taxes, are estimated to be approximately $35.1 million.

9.3.4 State and Local Value Added Benefits

IMPLAN was used to calculate the value added benefits to Custer and Fall River Counties. Value added is a measure of wealth created by an economy, in other words, as an industry buys goods and services and remanufactures those goods to create a product of greater value, this increase in value represents the value added. The IMPLAN model calculates the value added based on four components, employee compensation, proprietor income, other property income and indirect business tax. Employee compensation is wage and salary payments as well as benefits. Proprietary income consists of payments received by self-employed individuals as income. Other property type income consists of payments from interest, rents, royalties, dividends, and profits. Indirect business taxes consist primarily of excise and sales taxes paid by individuals to businesses. As shown in Table 9.3-4, the results from the IMPLAN analysis indicate that the construction, operation and reclamation stages of the proposed project are expected to generate approximately $186.7 million in value added benefits over the life of the proposed project.

Table 9.3-4: Value Added Benefits

	Construction 2 years	Operation 7 years	Reclamation 7 years	
South Dakota/Fall River & Custer Counties				**Total**
Value Added (per annum)	$39,091,679	$14,135,859	$1,366,119	
Total	$78,183,358	$98,951,013	$9,562,833	$186,697,204

9.3.5 Benefits of Environmental Research and Monitoring

Due to the remoteness and low population of the PAA, the ongoing environmental baseline studies and monitoring have greatly increased the information available on area's natural resources. Required operational monitoring as presented in Section 5.0 will continue to provide beneficial scientific data about the area.

9.4 External Costs of Project Construction and Operation

This section of the BC analysis evaluates the external costs of the proposed project. Both short-term and long-term external costs are also identified and described for people living in the surrounding communities not directly involved in the proposed project.

9.4.1 Short Term External Costs

9.4.1.1 Housing Shortages

Because of the proposed project's close proximity to the more populated communities of Custer City and Hot Springs, South Dakota and Newcastle, Wyoming with a combined population greater than 9,000 people, it can be assumed that much of the workforce would come from these localities. The remaining workforce would likely relocate from the surrounding area (e.g., South Dakota, Nebraska and Wyoming). The IMPLAN model results show that during the two year constructional stage, the proposed project has the potential to sustain the creation of 257 new jobs for two years. During the following 7 year operation stage the proposed project has the potential to sustain the creation 155 jobs for seven years, and 23 jobs over the final seven years.

In the unlikely event that the entire direct payroll and non-payroll workforce relocated to Custer and Fall River counties, the population increase for the three stages of operations would be 619, 374 and 58, based on the average family size in South Dakota of 2.41 as of 2006. This increase in population would account for an increase of 6.9 percent (total population 15248) in the total population of Custer and Fall River counties. This is a very conservative estimate because it is likely that a large percentage of the workforce for operation and reclamation will be sourced from the existing workforce, thereby reducing the total population increase substantially. The impacts associated with an increase in population are expected to be dispersed because of the remoteness of the proposed project site and the phased nature of construction, operation and reclamation. While this is a moderate increase in the overall percentage of the local population, this influx of immigration could be partially mitigated by implementing a preferential hiring scheme and using regional educational/training institutions to help train workers and to ensure that as many of the local residents are hired as possible.

9.4.1.2 Impacts on Schools and Other Public Services

There are several schools located within Custer and Fall River Counties. The Custer School District includes: Custer Elementary, Hermosa Elementary, Fairburn Elementary, Spring Creek Elementary, Custer Middle, and Custer High School. Total enrollment for the Custer School

District is 991 students with a student to teacher ratio of 12.1 to 1. The Hot Springs School District includes: Hot Springs Elementary, Hot Springs Middle and Hot Springs High School. Total enrollment for the Hot Springs School District is 873 students with a student to teacher ratio of 12.9 to 1. The Edgemont School District includes: Edgemont Elementary, Edgemont Junior High and Edgemont High School with a total enrollment of 138 students and a student to teacher ratio of 8.8 to 1.

Families moving into the aforementioned school districts near the proposed project site as a result of the proposed project are not expected to strain the current school system because they presently under-capacity as shown by the combined student teacher ratio for the three school districts of 12.1:1 as compared to the State wide student teacher ratio of 13.4:1 and the national average of 15.7:1.

The costs associated with increased demand of public facilities and services are expected to be minimal. The need for additional water supply and waste disposal facilities are expected to be minimal based on adequate existing capacity. Existing emergency response and medical treatment facilities are capable of responding to any possible incident at the proposed project site; therefore the basic services required to support the proposed project already exist. Since much of the workforce will be local and the aforementioned services should be capable of handling the increase in demand from immigration related to the proposed project, there are no significant changes or stresses anticipated for other public services, such as police, health care, or utilities.

9.4.1.3 Impacts on Noise and Congestion

There are only a few residences in the vicinity of the proposed project. Most of the land in the surrounding a 2 km radius of the proposed project is devoted to rangeland. Other land uses include grazing, crop land, hunting and wildlife habitat. As a result of the low population density of the area surrounding the proposed project site, the anticipated limited use of large machinery and vehicles and the infrequent movement of transport vehicles to and from the proposed project site, no significant noise or congestion impacts are anticipated within the surrounding 2 km area during operations. There will be some increased traffic, noise and dust on the county road between the site and Edgemont during construction activities. However, these impacts will be of short duration.

9.4.2 Long Term External Costs

9.4.2.1 Impairment of Recreational and Aesthetic Values

While several opportunities for recreational activities exist in the Custer and Fall River counties surrounding the proposed project and within the proposed project's surrounding 2 km area, the current recreational use is limited to deer, elk, and antelope hunting. During operations, hunting will be restricted within the permit boundary for safety reasons. However, this activity will not be permanent as hunting will return following reclamation of the site.

Within a 50-mile radius of the proposed project, recreational areas include Buffalo Gap National Grassland, the George S. Mickelson Trail, the Black Hills National Forest, Jewel Cave National Monument, Angostura State Recreation Area, Custer State Park, Mount Rushmore National Memorial and Wind Cave National Park.

While the proposed project is geographically located within 50 miles of several federal and state recreational areas, it will have only a minor affect on the regional recreational and aesthetic values because of its remote location and its limited access to large or highly traveled state roads or federal highways that service these recreational areas. Also, the proposed project will not impair the existing aesthetic values of the area due to limited surface land disturbance and the construction of minimal structures that will not be visible from any major highway or scenic vantage point in the area.

9.4.2.2 Land Disturbance

The land that encompasses the PAA has been historically used for cattle grazing and open-pit uranium mining operations. Therefore, the proposed project site has been previously disturbed and impacted from agricultural and mining activities.

The in situ leach (well field) method of uranium mining minimizes land surface disturbance in comparison to conventional surface or underground mining and milling methods that cover large areas and generate waste rock and mill tailings. In addition, the land surface disturbance associated with constructing ISL well fields and access roads will only be short-term as concurrent reclamation with native vegetation will occur throughout the life of the proposed project. Short-term surface disturbance impacts could result from the construction and operation of the CPP, surface impoundments and irrigated land until final reclamation and closure of these facilities is completed.

A Level III cultural resources evaluation and report have been prepared (Appendix 2.4-A) that includes a survey of archaeological sites within the entire permit boundary. Sites that may require additional data evaluation or recovery will be avoided as well field development progresses. More detail is provided in Section 2.4 on cultural resources within the PAA.

9.4.2.3 Habitat Disturbance

The PAA has historically been used for cattle rangeland and has been the site of mining and exploration projects since the 1950's. There are no anticipated adverse impacts or irreversible loss of surface vegetation or wildlife habitat relative to existing conditions as a result of proposed project operations. All of the disturbed land will be reclaimed after the proposed project is decommissioned and will become available for its pre-operational uses. Potential environmental impacts to vegetation and wildlife are discussed in Section 7.2.7.

9.4.3 Groundwater Impacts

Operational controls during production and groundwater restoration will assure that leach fluids are contained and will not impact nearby underground sources of drinking water. The use of groundwater supply for operations will be a temporary commitment of water resources and Powertech (USA) expects that the proposed groundwater restoration techniques will be successful at returning the production zones at the proposed project site to restoration target values, which will help protect underground sources of drinking water and allow the aquifers impacted to return to their pre-operational class of use. Potential impacts to groundwater resources are discussed in Section 7.2.5.

9.4.4 Radiological Impacts

The potential radiological impacts due to the proposed project during operation are small (as discussed in Section 7.3). The decommissioning of the Proposed project site and disposal of radioactive material will follow all applicable NRC requirements and/or license conditions and will be transported off site to an NRC or Agreement State licensed 11e.(2) disposal facility. The radiological effects including estimated exposures from the water and air pathways are discussed in Section 7.3.

9.5 Cost-Benefit Summary

The most significant benefits of the proposed project are its potential to sustain the creation of 257 new jobs during construction, 155 jobs during operation, and 23 jobs during reclamation, all of which include the direct, indirect and induced effects on the local economies. In addition, an estimated $91.6 million during construction will be spent on non-payroll expenditures, $148.4 million during operation and 14.0 million during reclamation; and approximately $35.1 million in state and local tax revenue and $186.7 million in value added benefits are expected to be generated over the life of the proposed project (Table 9.5-1) as a result of the proposed project.

Table 9.5-1 summarizes the associated short-term and long-term cost of the proposed project. Impacts to the regional housing market should be minimal because of the large percentage of local workers, impacts to schools and public facilities should be negligible because of their present ability to absorb any associated regional influx, and the impact of noise and additional traffic presents little or no change compared to the no action alternative. Due to the remote location of the proposed project and minimal surface disturbance, impacts to recreational activities and aesthetic values within the area should be negligible.

This cost-benefit analysis indicates that the construction and operation costs including capital costs of this proposed project will result in positive economic benefits to the local and regional economy by the creation of hundreds of jobs and millions of dollars in tax revenue over the life of the proposed project. The development of the proposed ISL project should present Custer and Fall River counties with net positive gain when compared to the no action alternative.

Table 9.5-1: Summary of Benefits and Costs for the Project

Benefits	Costs
Value Added	**Housing Impacts**
$186,697,204	Little or no change
Tax Revenue	**Schools and Public Facilities**
$35.1 million	Negligible
Potential to create temporary and permanent jobs	**Noise and Congestion**
	None
257 jobs over two years (2009-2010) during construction	**Impairment of Recreation and Aesthetic Values**
155 jobs over seven years (2011-2017) during operation	Negligible
	Land Disturbance
23 jobs over seven years (2018-2024) during reclamation	Minor
	Groundwater Impacts
Increased knowledge of the local environment and natural resources	Controlled through mitigation
	Radiological Impacts
	Controlled through mitigation

9.6 References

IMPLAN 2004, "*IMPLAN Professional Version 2.0 Manual Third Edition*", Minnesota IMPLAN Group, Inc., February.

U.S. Office of Management and Budget (OMB), 1992, Circular No. A-94, "*Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*".

Zerbe, R. O. and A. S. Bellas 2006, "*A Primer for Benefit-Cost Analysis*". Northampton, MA: Edward Elgar.

10.0 Environmental Approvals and Conclusions

In order for the Dewey-Burdock Project to operate, permits and approvals from numerous Federal and State agencies will be required. Section 10.1 identifies the issuing agencies, a description of the type of permit, license or approvals needed, and the current status of securing these approvals.

10.1 Applicable Regulatory Requirements, Permits, and Required Consultations

Necessary environmental approvals from Federal and State Agencies required for the proposed project are listed in Table 10.1-1. The NRC licensing process for a source materials license represents the longest lead-time approval. The majority of the remaining approvals are in-progress or will be initiated with in the next year. All necessary approvals must be secured prior to commencement of commercial production at the site.

Figure 10.1-1: Permits and Licenses for the Dewey-Burdock Project

Issuing Agency	Description	Status
South Dakota Department of Environment and Natural Resources Joe Foss Building 523 E Capitol Pierre, SD 57501	Uranium Exploration Permit	Submitted
	Temporary Water Right for Testing	Submitted
	Temporary Discharge Permit for Testing	Submitted
	Scenic and Unique Lands Designation	Submitted
	Large Scale Mine Permit	Pending
	Water Appropriation Permit	Pending
	Class III Underground Injection Control Permit	Pending
	Aquifer Exemption	Pending
	Air Quality Permit	Pending
	Groundwater Discharge Permit	Pending
	NPDES Water Discharge Permit	Pending
US Nuclear Regulatory Commission Washington, DC 20555	Source Materials License	Application Submitted herein
US EPA Region 8 8OC-EISC 1595 Wynkoop St Denver, CO 80202-1129	Aquifer Exemption	Pending
	Class III Underground Injection Control Permit	Pending
Custer County 420 Mount Rushmore Road Custer, SD 57730-1934	Building Permits	Pending
Fall River County County Courthouse Hot Springs, SD 57747-1309	Building Permits	Pending

10.2 Environmental Consultation

Over the course of license application preparation, consultations were conducted with several State and Federal agencies as listed in Table 10.2-1 below.

Table 10.2-1: State and Federal Agencies Contact Information

State Agency	Department	Location
South Dakota Game Fish and Parks	Wildlife	523 East Capitol Avenue Pierre, SD 57501
South Dakota State Archaeologist	Archaeologist	P.O. Box 1257 Rapid City, SD 57709-1257
SD Dept of Environment and Natural Resources	Minerals and Mining Program	523 E Capitol Ave Pierre, SD 57501
Federal Agency		
U.S. Geological Survey	Dakota Mapping Partnership Office	1608 Mountain View Road Rapid City, SD 57702
U.S. Army Corps of Engineers	Resource Management	441 G. Street, NM Washington, DC 20314-1000
U.S. Forest Service, South Dakota	Supervisor's Office in Custer, SD	25041 North US Highway 16 Custer, SD 57730-7239
Natural Resources Conservation Service	Pierre Service Center	1717 N Lincoln Ave Pierre, SD 57501-2398
U.S. Nuclear Regulatory Commission	Uranium Recovery Licensing Branch	Washington, DC 20555-0001
US EPA Region 8	8P-W-GW	1595 Wynkoop Street Denver, CO 80202-1129

The 23 Drawings specifically referenced in the Table of Contents have been processed into ADAMS.

These drawings can be accessed within the ADAMS package or by performing a search on the Document/Report Number.

D-35 through D-57